The Impact of Maternal BMI Status on Pregnancy Outcomes with Immediate Short-Term Obstetric Resource Implications: A Meta-analysis

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1. Title

The Impact of Maternal BMI Status on Pregnancy Outcomes with Immediate Short-Term Obstetric Resource Implications: A Meta-analysis

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4. Key Words

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5. Running Title

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8. Conflict of Interest

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1. Abstract

Introduction: Obesity is rising in the obstetric population, yet there is an absence of services and guidance for the management of maternal obesity. This systematic review aimed to investigate relationships between obesity and impact on obstetric care.

Methods: Literature was systematically searched for cohort studies of pregnant women with anthropometric measurements recorded by 16 weeks gestation, followed up for the term of the pregnancy, with at least one obese and one comparison group. Two researchers independently data extracted and quality assessed each included study. Outcome measures were those that directly or indirectly impacted on maternity resources. Primary outcomes included instrumental delivery, caesarean delivery, duration of hospital stay, neonatal intensive care, neonatal trauma, haemorrhage, infection, and $3^{rd}/4^{th}$ degree tears.

Results: Meta-analysis shows a significant relationship between obesity and increased odds of caesarean and instrumental deliveries, haemorrhage, infection, longer duration of hospital stay, and increased neonatal intensive care requirement.

Conclusions: Maternal obesity significantly contributes to a poorer prognosis for mother and baby during delivery and in the immediate postpartum period. National clinical guidelines for management of obese pregnant women, and

public health interventions to help safeguard health of mothers and their babies are urgently required.

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2. Introduction

Obesity is a growing problem and tackling obesity is a major focus for public health in the United Kingdom (UK). The Choosing Health White Paper identified obesity as one of the key priority areas in public health [1], and the UK Government's Foresight Programme aims to identify a sustainable response to obesity over the next 40 years [2].

The prevalence of obesity in women in England has risen from 16.4% to 24.8% between 2003-2005, with the highest prevalence amongst Black African (38%), Black Caribbean (32%) and Pakistani ethnic groups (28%) [3]. There is an absence of national statistics on the impact this increasing prevalence of obesity in women has on obesity in pregnancy. The Health Survey for England (HSE) showed that the prevalence of obesity in women of childbearing age (16 to 44 year old) was 17.8% [4]. CEMACH reported that 30% of all mothers who died during 2000-2002 were obese (BMI>30kg/m^2) [5], by 2003-2005 more than half were overweight or obese (BMI>25kg/m^2), with over 15% being morbidly (BMI>40kg/m^2) or super morbidly obese (>50kg/m^2) [6]. Despite the absence of national statistics, three UK studies show incidence rates of maternal obesity have increased from 9.9% to 16.0% between 1990-2004 in Middlesbrough [7], from 3.2% to 8.9% between 1990-1999 in Cardiff [8] and from 9.4% to 18.9% between 1990-2002/4 in Glasgow [9]. Trends in maternal obesity on an international level are difficult to compare directly due to different criteria in measurement being used, however Guelinckx et al [10] summarise that obesity varies from 1.8% to 25.3% of the pregnancy population using the World Health Organisation criteria of a BMI>30kg m^2.

Obesity has an impact on women's reproductive health, and there are health risks to both mother and her infant. There is a relationship with polycystic ovarian syndrome (PCOS), infertility, and the success of infertility treatment [11], whereas weight loss has been shown to alleviate these conditions and improve the success of infertility treatment [12]. There is an increased risk of mothers developing gestational diabetes [13] and subsequent development of diabetes mellitus [14], an increased risk of hypertensive disorders and pre-eclampsia [14, 15], and thromboembolic complications [15]. There is some evidence of an increased risk of late fetal loss [16] and stillbirth [17]. The Confidential Enquiry into Maternal and Child Health (CEMACH) reported that in 2005 mothers were obese in 22.9% of all late fetal loss, 30.4% of stillbirths, and 30.6% of neonatal deaths [18]. Congenital anomalies have been linked with obesity. Waller et al [19] found that mothers of offspring with spina bifida, heart defects, anorectal atresia, hypospadias, limb reduction defects, diaphragmatic hernia, and omphalocele were significantly more likely to be obese than mothers of controls (odds ratios ranging between 1.33 and 2.10).

In addition to the obesity related health risks there is also an impact on service. CEMACH recommends that the care of women with a BMI≥35kg/m^2 should be "shared with an obstetrician and [the mother] advised to deliver in a consultant led obstetric unit" as they are at a higher risk of developing problems [5]. This recommendation is supported by the National Institute for Health and Clinical Excellence (NICE) in their Guidelines for Antenatal Care

[20] which state that women with a BMI ≥35kg/m^2 are likely to need additional care outside routine guidelines. However national guidance specific to the needs of obese mothers' antenatal care is not currently available. Heslehurst et al [21] discuss the impact of obesity in pregnancy on the National Health Service (NHS) maternity services as described by the health care professionals caring for women during their pregnancy. A number of the issues identified have supporting quantitative evidence, such as the need for more frequent caesarean deliveries [22]. Galtier-Dereure et al [23] concluded that the pre-natal care cost in overweight and obese women was 5.4-16.2 fold higher compared with ideal weight women. However this study only considered the cost of in patient and outpatient hospitalisation in obstetric and surgical units, whereas the impact of obesity on resources has been shown to exceed pure hospitalisation costs [21]. There is an absence of published studies addressing the quantifiable impact of maternal obesity on service delivery in its entirety.

The aim of this systematic review was to identify the immediate impact on obstetric care when women are obese at the start of pregnancy.

3.1 Methods

Electronic databases MEDLINE, CINAHL, the Cochrane Database of Systematic Reviews, Database of Abstracts of Reviews of Effects, NHS Economic Evaluation Database, and the Midwives Information and Resource Service (MIDIRS) were searched from 1990 to June 2007. Searches were limited to English language studies in humans. References of all published review articles identified and included studies were searched for other eligible studies. A search strategy was developed for MEDLINE and adapted for CINAHL (Box 1 available online and from authors). MIDIRS was searched using their standard search on obesity, and Cochrane was searched using the MeSH facility for pregnancy and obesity, and using the search facility and the following terms: (obes* or overweight) AND (pregnan* or matern*).

Titles and abstracts of all studies identified in the search were scanned and full papers of any studies that were associated with maternal obesity were retained for further independent evaluation by two reviewers. Any disagreement on the inclusion of a study was assessed by a third reviewer.

Inclusion criteria for the review were:

- Maternal weight or Body Mass Index (BMI) was recorded prior to 16 weeks gestation
- Measured or self reported weight was recorded at the start of pregnancy (studies were excluded when women were asked to recall their pre-pregnancy weight postnatally)
- There was at least one obese and one comparison group
- Women were followed up for the duration of the pregnancy and delivery
- Studies were included whether women were categorised into groups based on their BMI, other weight for height measure, or weight alone (only studies using BMI were included in the meta-analysis)

The primary outcome measures being reviewed were those with a major direct NHS resource association; secondary outcome measures were those with an indirect resource association. Primary outcome measures included instrumental and caesarean delivery, length of hospital stay, neonatal intensive care, neonatal trauma, maternal haemorrhage and infection, and 3rd/4th degree tears.

The searches identified 919 records following deduplication and 799 were excluded based on the titles and abstracts. 120 were screened, plus an additional six studies identified through citation searching, of which 77 were excluded (figure 1). Forty-nine studies were eligible and included in the review.

Data Extraction and Quality Assessment:

Included studies were data extracted and quality assessed by two researchers independently. One researcher (NH) carried out data extraction and quality assessment for all studies for consistency. The data extraction utilised the Cochrane data extraction template for cohort studies [24], and the quality assessment forms were based on the Scottish Intercollegiate Guidelines Network (SIGN) methodology checklist for cohort studies [25]. Studies were quality assessed and given a score of low (-), good (+), or excellent (++) based on internal validity, overall assessment of the study, and description of the study.

Data Analysis:

Data were combined for meta-analysis when the following criteria were satisfied in three or more studies:

1. The definition for the outcome data being analysed were sufficiently similar that the clinical service implications could be compared
2. The definition of maternal body weight status utilised BMI
3. Where possible the control group BMI categories were comparable

Where the data was not presented as an odds ratio it was calculated. A p-value <0.05 was indicative of significant heterogeneity being present. Tests for heterogeneity between combined study results were carried out in STATA [26] to identify whether the variation between studies was attributable to chance. Sensitivity analysis was carried out in this instance accounting for those studies where the results were crude or adjusted, results being split by level of obesity (moderate, severe, or morbid obesity), quality score of the studies, and consistency in BMI cut off used. Results of the meta-analysis are presented as OR's and 95% confidence intervals (CI) where possible.

3.2 Description of Studies

Study characteristics are described in table 1 (available online and from authors), and the quality scores and adjustments in table 2 (available online and from authors). Included studies were primarily from the USA (n=22) [27-48], and Europe (n=20; four from Finland [49-52] and Denmark [53-56], three from the UK [8, 57, 58], Italy [59-61] and Sweden [62-64], two from France [23, 65], and one from Austria [66]). The remaining studies included one from Australia [67], Canada [68], Abu Dhabi [69], Brazil [70], Thailand [71], Israel [72], and Iran [73]. Four of the 49 studies were excluded from the meta-analysis due to BMI not being the measurement of obesity. All studies presented data in odds ratios, or had data available for the authors to calculate the odds ratios [74] (tables 3-10).

3.3 Results

Primary Outcomes

Most primary outcomes showed increasing odds associated with increasing BMI category (table 11).

Labour and Delivery Meta-analysis:

There are increased odds of instrumental delivery in obese women (figure 2), whereas there appears to be significant reduced odds for instrumental delivery in overweight women when compared with women of an ideal BMI. Meta-analysis could not be carried out for underweight women and instrumental delivery, however there was no significant relationship between these factors in the one study identified [54].

Being overweight, obese, or morbidly obese shows significant increased odds for overall and emergency caesarean delivery (figures 3 and 4) but this is not significant for elective caesarean delivery (figure 5). Being underweight has reduced odds with the need for caesarean delivery. For the overall caesarean delivery rate (including studies where the definition of emergency or elective caesarean delivery has not been specified) the meta analysed results do not show an exponential trend with increasing obesity. However there are only six studies included in the review that categorise obesity into subgroups that allowed the separate analysis of morbid obesity compared with ideal BMI (figure 4), whereas 16 studies analysed obesity generically (figure 3) and this might be masking a true exponential trend. It is worth noting that when studies were meta analysed comparing morbid obesity to “non obese” rather than ideal BMI group (n=3), the odds of a caesarean delivery being required increased to 2.36 from 1.43 when compared with ideal BMI only.

Hospital Admission Meta-analysis:

There was a significant gradual increase in mean length of hospital stay as BMI increased, from 2.4 days for ideal BMI to 3.3 days for morbidly obese women (figure 6). The data from individual studies included in the meta-analysis showed an overall length of stay as being between 2-3 days for those women with an ideal BMI, 2-4 days for women who were overweight or obese, and 3-5 days for women who were morbidly obese (table 10). The neonatal requirement for intensive care was not significant for overweight women, but was shown to be increased for both obese and morbidly obese women (figure 7). Neonatal intensive care requirements for underweight women could not be meta analysed, however two studies found an increased odds of 1.3 (1.0, 1.5) [50] and 4.30 (1.32, 13.97) [43], when compared to women with an ideal BMI.

Maternal Complications Meta-analysis:

Women who were overweight, obese, and morbidly obese had significantly increased odds of haemorrhage when compared with women with an ideal BMI (figure 8), whereas being underweight has reduced odds for this outcome. The rate of infection (including wound n=2, abdominal wound n=1, combined wound and uterine n=1, and combined wound, urinary tract, perineum, chest, and breast n=1) was significantly higher in obese women with almost a 3 and a half fold increase when compared with women of an ideal BMI (figure 9). Meta-analysis could not be carried out for under or overweight women; however two studies did not show a significant relationship with either of these BMI groups [32, 66].

Maternal Complications Non Meta-analysis:

It was not possible to combine studies for 3rd and 4th degree tears due to an insufficient number of identified studies. One study showed no significant relationship between anal sphincter laceration and moderate, severe, or morbid obesity when compared with women in the ideal BMI group [62], and one study showed no relationship with 3rd/4th degree tears when obese women were compared with non obese women [8].

Neonate Non Meta-analysis:

It was not possible to combine studies for neonatal birth trauma due to an insufficient number of studies being identified in the search. The studies that were identified showed a significant increase in trauma incidence (where trauma was defined as cuts, grazes, bruises, fractures, muscle haematomas, dislocation, cephalhaematomas, and nerve palsies) in obese mothers when compared to non obese (OR 1.50, 1.10, 2.10) [8], whereas there was no statistically significant relationship with obesity, overweight or underweight and skull fracture [42].

<u>Secondary Outcomes</u>

The results of the meta-analysis for the secondary outcomes that may incur an indirect resource implication for maternity services are shown in table 12.

Birth weight and Growth Meta-analysis:

There is a trend for an increasing mean birth weight and high birth weight with increasing BMI category, and significant reduced odds of high birth weight when mothers are underweight. However there were not enough studies to analyse high birth weight and morbid obesity separately to that of overall obesity. The trend for low birth weight is significantly higher in underweight women compared with women in the ideal BMI group, with significant reduced odds for women who are overweight and obese. The morbidly obese group shows a slight increase in low birth weight; however this is not significant (OR 1.11, 0.92, 1.34).

There is an increasing odds of postdate delivery as the BMI category increases. Meta-analysis could not be carried out for underweight and post-date data; one study showed reduced odds (OR 0.87, 0.8, 0.94) [55], whereas another study showed no significant relationship (OR 1.0, 0.7, 1.4) [50]. Interestingly in addition to having an increased odds of post-date delivery, there was also an increasing odds of preterm delivery at <37 weeks with increasing BMI category, whereas underweight was not significant. Delivery at <32 weeks (which has the biggest impact on service in terms of neonatal care) showed a positive relationship with obesity with an increased rate of over one and a half fold when compared with women in the ideal BMI group. The meta-analysis showed no significance in the results at 34 weeks for obese women.

Labour and Delivery Meta-analysis:

There are increased odds for induction of labour in overweight and obese women, and failure to progress with the labour is more than twice as likely in obese women. The odds for requiring oxytocin or epidurals are also increased, and although these outcomes could not be meta analysed by degree of obesity; one study shows an apparent increase in the requirement for epidurals with increasing severity of obesity [62].

There are significant reduced odds for vaginal delivery in both overweight and obese women, however morbidly obese and underweight BMI groups could not be meta-analysed for this outcome due to limited studies. Two studies identified no significant relationship with underweight [45, 49], whereas one study identified a significant reduced odds for morbid obesity and vaginal delivery (OR 0.52, 0.40, 0.67) [67]. The meta-analysis also showed significant slightly reduced odds for placenta previa in obese women, but no apparent relationship with placenta abruption.

Labour and Delivery Non Meta-analysis:

It was not possible to include a number of labour and delivery outcomes in the meta-analysis. One study found a 12 fold significant increase in having difficulty in determining fetal lie in obese women when compared to non obese women [58], mal presentation was significant with increased odds of 1.4 (1.2,1.6) in obese women [72] but this was not significant in overweight women [47], and incidence of occiput posterior was not found to be significant in obese, overweight, or underweight women [54]. Premature rupture of membranes (PROM) was identified to have increased odds of between 1.2

and 1.3 in three studies [48, 58, 72], however this was only significant in one study with odds of 1.20 (1.02, 1.5) [72].

Failed induction increased from 0% in the ideal BMI group, to 1.7% and 2.5% in overweight and obese mothers respectively [47]. Failed instrumental delivery was significantly higher in obese compared to non obese women in one study [8], whereas another study found no significance in either obese or overweight women when compared to the ideal BMI group [47]. Labour abnormalities (including prolonged latent phase, protracted active phase, secondary arrest of dilation, arrest of descent, prolonged second stage) were found to be significantly increased in overweight women when compared to underweight women (OR 1.78, 1.11, 2.81), but this was not found to be significant in obese women [38]. There was an increased odds of labour dystocia and obesity (1.67, 1.50, 1.86) [33], and duration of labour ranged between a mean of 4.7 hours (SD 2.8) [23] to 8.1 hours (SD 4.2) [8] for obese women, compared to 5.7 hours (SD 2.9) [23] to 7.7 hours (SD 4.0) [8] in non obese women.

Only one study measured pain and obese women were found to have a lower median pain score compared to women with an ideal BMI (9 and 8 respectively). However the proportion of women who reported a high pain score of 7-9 was slightly higher in the obese group (85% versus 83%) [51]. There was also an increased odds of obese women requiring nitrous oxide (OR 6.43, 3.17, 13.04) and pethidine (OR 12.35, 3.00, 50.89) [51].

Hospital Admission Non Meta-analysis:

Studies looking at hospitalisation could not be meta-analysed, however most showed an increasing level of hospital contact with obesity and overweight. For moderate obesity and severe or morbid obesity the odds of outpatient hospitalisation were 10.42 (3.05, 35.55) and 20.00 (5.51, 72.58) respectively when compared with women in the ideal BMI group [23]. This pattern was reflected in the odds of inpatient hospitalisation being 5.60 (1.75, 17.90) for moderate obesity, and 18.51 (5.44, 62.99) for severe or morbid obesity, and increased hospitalisation was also shown in the overweight group (OR 6.25, 1.92, 20.38 for outpatient, and 4.90, 1.63, 14.70 for inpatient hospitalisation). The odds of overall admission to hospital was also increased in obese women when compared to women with an ideal BMI (OR 2.67, 2.15, 3.32) but not significant for underweight women [50]. Readmission to hospital showed a significant relationship with underweight (OR 3.36, 1.84, 6.12) but was not found to be significant for obese or overweight women [66].

Neonate Meta-analysis:

There is no significant relationship with apgar score at 1 minute and maternal obesity, however having a low apgar score at 5 minutes increases by one and a half fold in obese women, and this rises two fold if the mother is morbidly obese. The relationship between apgar score and underweight could not be meta-analysed, however no apparent significant relationship with apgar score a 1 minute [50] or 5 minutes [54] was found.

There is a significant increase in fetal compromise in the overweight, obese and morbidly obese groups, and there are increased odds of meconium being present when mothers are obese. Fetal compromise in underweight women could not be meta-analysed but was found not to be significant in two studies [31, 32]. There doesn't appear to be any significant relationship with shoulder dystocia (figure 10), however the control groups for this outcome included both ideal and non obese BMI. Following sensitivity analysis including only ideal BMI control groups no significance remained (OR 1.02, 0.95, 1.11). Jaundice in neonates born to obese mothers showed no significance; however the analysis could not be carried out for morbid obesity separately for either jaundice or shoulder dystocia. One study that provided data on morbid obesity showed a significant increase in the odds of jaundice (OR 1.44, 1.09, 1.89) [67], but there remained no significance for shoulder dystocia [62].

Neonate Non Meta-analysis:

There were a number of outcomes affecting the neonate that have an impact on resources and could not be meta-analysed. No significant relationship between obesity or overweight and the need for mechanical ventilation was reported [67], whereas there appears to be a significant relationship with obesity and incubator requirement (OR 1.64, 1.02, 2.63) [8], respiratory distress (OR 1.71, 1.38, 2.11) [42], and resuscitation (OR 1.75, 1.26, 2.43) [32], with similar findings in the overweight BMI group [32, 38, 42], but not in the underweight group [32, 42]. There is a reported increased odds of fetal heart rate abnormalities in both obese and overweight women (OR 1.33, 1.01, 1.67 and 1.38, 1.03, 1.85 respectively) [38], and increased tube feeding required (OR 1.51, 1.08, 2.10) [8]. The incidence of asphyxia was not found to be significantly related to obesity, overweight, or underweight [8, 54], obesity and overweight appear not to be related to the incidence of hyperbilirubinaemia [60], hypoglycaemia [53], or cord pH<7.2 [8].

Maternal Complications Meta-analysis:

Third and fourth degree tears are considered to be a primary outcome with a direct NHS resource implication; however these have been combined with the other reported tears (perineal tear/trauma, and vaginal repair) due to insufficient studies being suitable for meta-analysis. There was no significant relationship with tears and lacerations and maternal obesity. It was not possible to meta-analyse underweight or overweight and tears, however there was no apparent relationship with overweight and perineal trauma [32, 54], whereas underweight was seen to have a significantly inverse relationship with perineal trauma in one study (OR 0.70, 0.49, 0.99) [32], and another study identified no significant relationship [54].

Maternal Complications Non Meta-analysis:

The maternal outcomes identified as having resource implications that could not be meta-analysed were retained placenta, evacuation of uterus, thromboembolic events and puerperal complications, and these largely showed no significant relationship with BMI group [8, 32, 54, 58, 66, 72]. One study did show significantly reduced odds for retained placenta in the underweight group when compared to women in the ideal group [32]; however these results are not supported by a second study which identified no significant relationship between these factors [54].

4. <u>Discussion</u>

The findings of this review have been split into outcomes which are deemed to have the greatest impact on services in terms of direct resource implications, and those outcomes which have the potential to lead to additional care being required that would also impact on NHS maternity service provision. A number of the outcomes identified as having a significant positive relationship with obesity support the findings of qualitative research carried out with health care professionals to identify their views on the impact of obesity on maternity service provision [21].

This review has identified a relationship between obesity and increased demand for deliveries that require additional resources such as instrumental and caesarean deliveries, and an inverse relationship with vaginal delivery. A vaginal delivery is the least costly option when considering the resources required for the NHS in both staffing and length of stay. The requirement for instrumental and caesarean deliveries increases the cost from £817 for a vaginal delivery without complications, to £1,129 for an assisted delivery and £1,682 for a caesarean delivery [75]. These costs are seen to rise further to £2,239 and £2,337 when the assisted and caesarean deliveries have complications. The increased rate of caesarean delivery may be attributed to women who are identified as having larger babies prior to the onset of labour, also those women who may fail to progress in the first or second stages of labour may require an emergency caesarean delivery. Both of these outcomes are shown to be positively associated with maternal obesity in this review. Women who have had previous caesarean deliveries are at increased risk of requiring subsequent caesarean deliveries [76, 77]. As obesity in pregnancy is associated with increasing parity in mothers [7], and pregnancy is a factor which promotes obesity due to gestational weight gain and inadequate weight loss between pregnancies [78-80], it would be reasonable to presume that increasing rates of repeat caesarean deliveries would be higher in those women who are obese. This is supported by Hibbard et al [81] where morbid obesity in women who had a previous caesarean delivery was associated with failure of a trial of labour, and increased requirement for caesarean delivery. Failure to progress with labour is also shown in this review to be over two fold higher in obese women, which in addition to a relationship with more frequent caesarean deliveries, demands more intense midwifery care and need for an increased number of epidurals.

The implications of a caesarean delivery in terms of the mother's health when they are obese should be considered. There are greater anaesthetic risks during surgery when obesity is a factor [82] and there is an increased risk of wound infections following surgery. The three and a half fold relationship with obesity and infections found in this review impacts on resources with the requirement for antibiotics and intravenous infusions, longer length of stay, and potentially debridement for severe wound infections which may require input from a plastic surgeon. The risk of haemorrhage is also shown to be increased in obese mothers, which may require longer hospitalisation, increased drugs, blood transfusion, fluids, and may result in a return to theatre and intensive care treatment.

The potential for the increased risk of caesarean delivery and longer length of stay is associated with a number of the secondary outcomes. In addition to the caesarean risks associated with high birth weight, low birth weight (especially in the case of intra uterine growth restriction (IUGR)), is also an indicator for early caesarean delivery in order to minimise the risk of further restricted fetal growth in utero. Morbid obesity poses a risk for clinicians to fail to diagnose IUGR due to an inability to obtain accurate fetal measurements, which could ultimately result in still-birth if there is no intervention at an appropriate stage. With high birth weight there are resources that maybe required in addition to caesarean delivery, such as repeat growth scans and clinic visits if the fetal measurements are above the cut off for gestational age, and the mothers may require additional tests to exclude diabetes, such as glucose tolerance or fasting glucose tests.

The gestational age at delivery has a potential impact on maternity resources. Post-dates tend to have a higher induction rate associated with increased requirement for caesarean delivery and longer hospitalisation. The resource implications for premature deliveries largely relate to neonatal special care or intensive care requirements; especially those deliveries under 32 weeks (where obese mothers have a one and a half fold increased risk). The neonatal risk of having a low apgar score at 5 minutes was shown to rise from over one and a half fold in the overall obese group, to over two fold in the morbidly obese group. The resource implications of having a low apgar score are increased input from paediatric teams, resuscitation, and neonatal care. Additional staff requirements such as medical teams and increased midwifery care are needed for other fetal outcomes such as signs of fetal compromise, which may result in repeat fetal blood sampling if there is an abnormal heart pattern on monitoring, an operative vaginal or caesarean delivery, staff input during delivery and neonatal care requirements. Meconium stain can be a sign of fetal compromise, however it can also be present in the case of postdate babies. If the meconium stain is significant a paediatrician may be required at the delivery therefore increasing staffing costs. In addition to the financial cost of neonatal intensive care, there is also a shortage of neonatal intensive care beds on a national level [83] and increased maternal hospitalisation adds to the increased pressure on bed capacity. In addition to the neonatal intensive care requirements, there is generally a longer length of stay when babies are premature. Large tertiary centres that provide care for premature deliveries require the facilities to care for mothers to stay both prenatally and post delivery, and there is a social cost because mother and baby are separated following birth.

In addition to the well documented health implications to the obese mother and her baby, the huge demand on NHS resources as a consequence of this is apparent. The safer childbirth minimum care requirements for service provision [84] include indicators for increased midwife to mother ratio. These indicators incorporate a number of the risks for obese women identified in this review. The lowest risk categories I and II are deliveries between 37 and 42 weeks, normal birth, no intervention, good birth weight and apgar score, and no epidural, requiring a 1:1 midwife to mother ratio. As the risk categories and midwifery ratios increase, the relationship with obesity and the indicators for increased midwifery care also increase. Category III requires a 1:1.12 ratio and includes induction, fetal monitoring, instrumental delivery, third degree tear and preterm birth, category IV includes the use of epidural and a 1:1.3 ratio, and the highest risk category requiring a 1:1.4 ratio includes emergency caesarean, medical or obstetric complications, and severe pregnancy induced hypertension.

Despite the adverse health implications and additional resource demand, there is an apparent lack of national guidelines for clinical practice, and an absence of public health interventions and research devoted to the prevention of maternal obesity. CEMACH [6] recommends that obese women are high risk group and require pre-conception counselling and support, especially in the case of fertility treatment, and stresses that guidelines are urgently needed for the management of obese women in pregnancy. This drive to develop clinical guidelines for the management of the obese pregnant woman is vital to help safeguard the health of mothers and their babies, and to develop public health interventions both prior to conception and postnatally to help prevent the rise in maternal obesity. Ideally women would have a healthy weight status prior to conception, and efforts need to be focused on adolescents and young women, potentially through school-based programmes and via family planning services. Developing a successful programme of public health interventions to prevent maternal obesity would stem rising NHS resource implications, and minimise the risks to both the mother and her baby.

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Box 1. Search Strategy

1. *pregnancy/
2. pregnan$.ti,ab.
3. matern$.ti,ab.
4. gravid$.ti,ab.
5. mother.ti,ab.
6. parent.ti,ab.
7. or/1-5
8. or/1-6
9. *obesity/ or *obesity, morbid/
10. obes$.ti,ab.
11. *Weight Gain/ph [Physiology]
12. (overweight or over weight or weight gain).ti,ab.
13. (bmi or body mass index).ti,ab.
14. or/9-13
15. (cohort or observation$ or prospective or longitudinal).ti,ab.
16. 7 and 14
17. 8 and 14
18. 16 and 15
19. 17 and 15
20. animal/
21. humans/
22. 20 not (20 and 21)
23. 18 not 22
24. 19 not 22
25. fertil$.ti,ab.
26. (IVF or in vitro fertili?ation).ti.
27. (PCOS or polycystic ovary syndrome).ti.
28. or/25-27
29. 23 not 28
30. 24 not 28
31. limit 29 to english language
32. limit 30 to english language
33. limit 31 to yr=1990-2007
34. limit 32 to yr=1990-2007

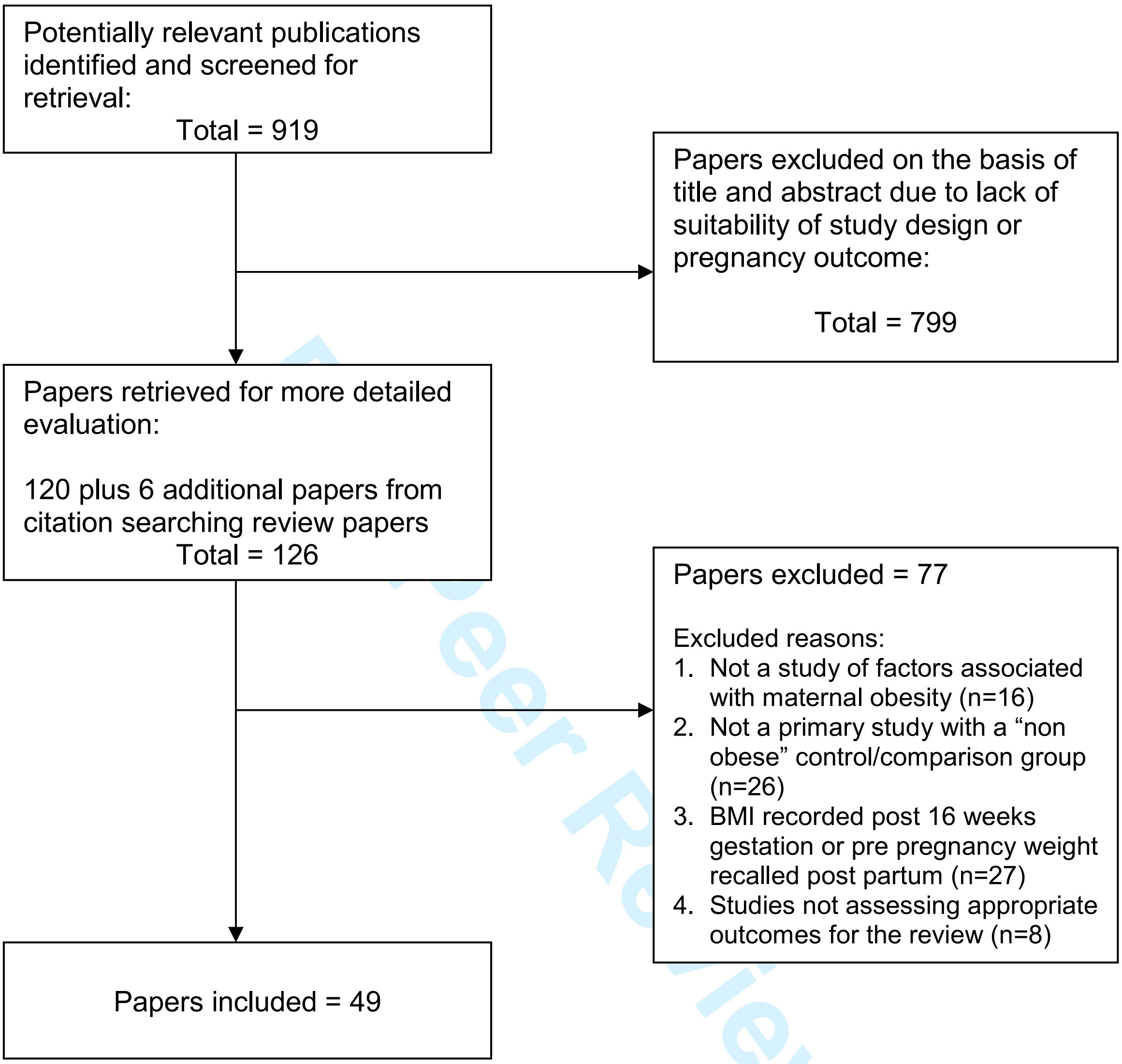
Box 2: Glossary of Obstetrics Terminology

- 3rd degree tears - involving fourchette, vagina, vulva, pelvic floor, perineal muscles, vaginal muscles, anal sphincter, recto-vaginal septum.
- 4th degree tears - as third plus; anal and/or rectal mucosa.
- Anorectal atresia - Congenital absence of an opening at the bottom end of the intestinal tract.
- Apgar score - a number arrived at by scoring the heart rate, respiratory effort, muscle tone, skin colour, and response to stimuli. Each of these objective signs can receive 0, 1, or 2 points. A perfect Apgar score of 10 means an infant is in the best possible condition. An infant with an Apgar score of 0-7 requires assessment and initiation of resuscitation.
- Asphyxia – a lack of oxygen delivery via the placenta which in turn can lead to morbidity and mortality for the fetus.
- Diaphragmatic hernia - Passage of a loop of bowel through a deficit in the diaphragm muscle. This type of hernia occurs as the bowel from the abdomen "herniates" upward through the diaphragm into the chest (thoracic) cavity.
- Fetal compromise (or distress) - Compromise of the fetus during the ante partum period (before labour) or intrapartum period (birth process). The term "fetal distress" is commonly used to describe fetal hypoxia (low oxygen levels in the fetus). The concern with fetal hypoxia is it may result in fetal damage or death if not reversed or if the fetus is not promptly delivered.
- Hyperbilirubinaemia - An elevated level of the pigment bilirubin in the blood. A sufficient elevation will produce jaundice.
- Hypoglycaemia – A clinical syndrome that results from low blood sugar.
- Hypospadias - A birth defect of the penis involving the urethra (the transport tube leading from the bladder to discharge urine outside the body).
- Instrumental delivery (forceps or Ventouse/vacuum) - An instrument designed as an aid in the vaginal delivery of a baby.
- Intra uterine growth restriction - The growth of the fetus is abnormally slow, or there is no growth. Intrauterine growth restriction is associated with increased risk of medical illness and death in the newborn. Intrauterine growth restriction is also referred to as intrauterine growth retardation.
- Meconium - Dark sticky material normally present in the intestine at birth and passed in the faeces after birth. The passage of meconium before birth can be a sign of fetal compromise.
- Occiput – Denominator of the fetal head
- Occiput anterior – Occiput points anteriorly, or slightly to the right or left in the mothers pelvis, this is the optimal position for labour
- Occiput posterior – occiput points posterior in the pelvis, either directly at the sacrum (direct OP) or to one side of it in the region of the sacroiliac joint (LOP, ROP). Often leading to a longer labour.

- Omphalocele - A birth defect in which part of the intestine, covered only by a thin transparent membrane, protrudes outside the abdomen at the umbilicus.
- Oxytocin - A hormone made in the brain that plays a role in childbirth by causing muscles to contract in the uterus (womb). A synthetic form is used in induction or augmentation of labour – syntocinon.
- Placenta abruption - Premature separation of the placenta from the wall of the uterus.
- Placenta previa - Rather than being attached to the upper wall of the uterus, the placenta lies low in the uterus, partly or completely covering the cervix.
- Polycystic ovarian syndrome (PCOS) - A disorder of chronically abnormal ovarian function and hyperandrogenism (abnormally elevated androgen levels).
- Pre-eclampsia - A condition in pregnancy characterised by hypertension (elevated blood pressure), albuminuria (leakage of large amounts of the protein albumin into the urine) and oedema (swelling) of the hands, feet, and face.
- Premature rupture of membranes – Rupture of membranes prior to onset of labour.
- Puerperium - The time immediately after the delivery of a baby and up to 6 weeks postnatal.
- Shoulder dystocia - Halt to spontaneous delivery because the baby's shoulder is wedged behind the mother's pubis, due usually to the baby being too big to fit through the birth canal.
- Thromboembolic complications - Formation in a blood vessel of a clot (thrombus) that breaks loose and is carried by the blood stream to plug another vessel.

http://www.medterms.com

Figure 1: Quorum Statement Flow Diagram



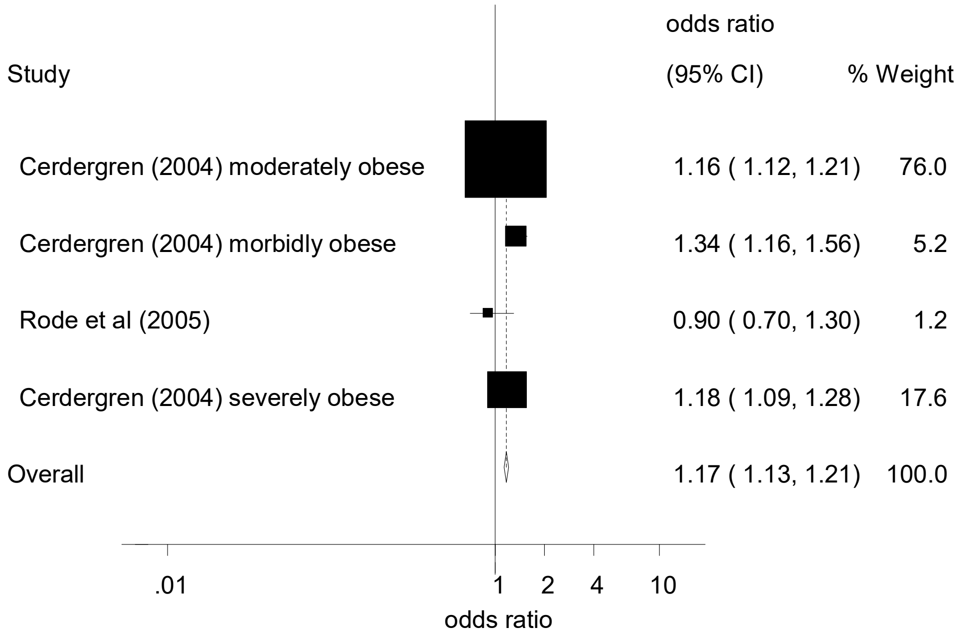


Figure 2: Instrumental delivery forest plot for obese BMI compared with ideal BMI following sensitivity analysis including adjusted odds ratios only

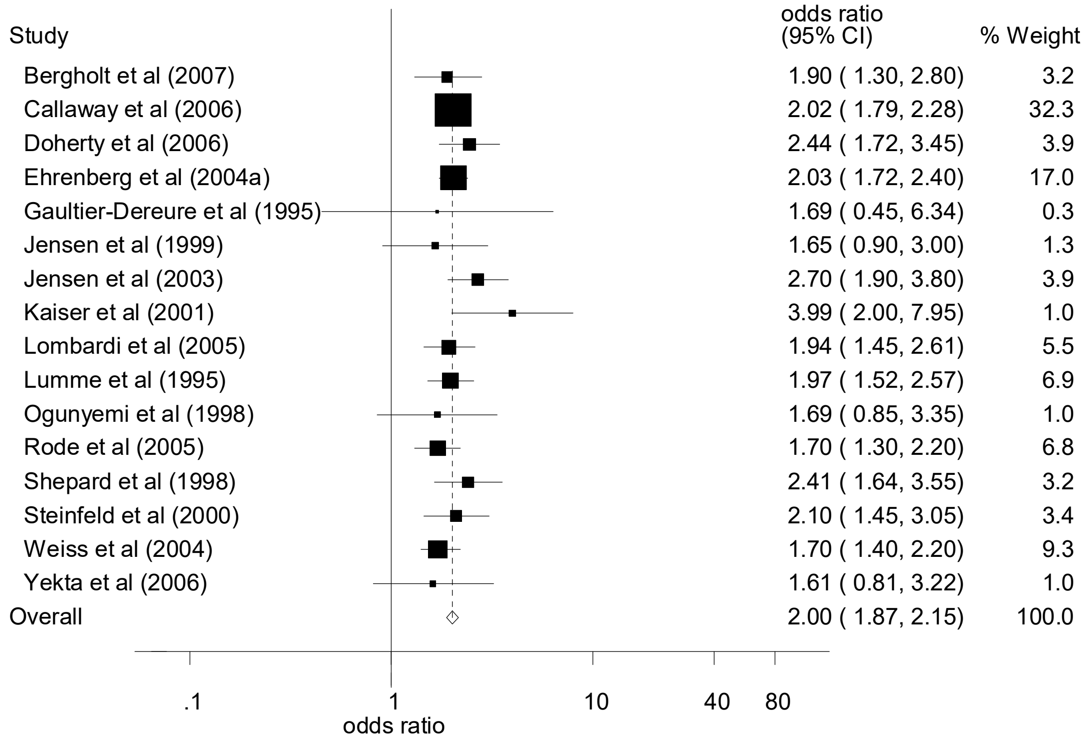


Figure 3: Overall caesarean delivery forest plot including emergency and elective caesarean delivery for obese BMI compared with ideal BMI following sensitivity analysis for control group definition

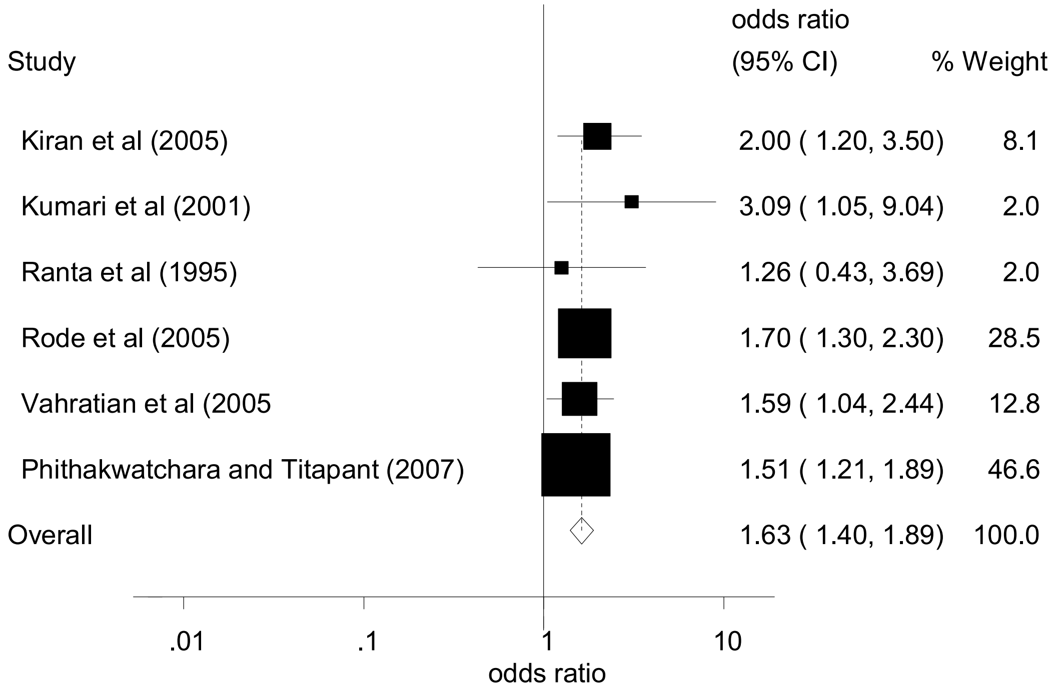


Figure 4: Emergency caesarean delivery forest plot for obese BMI compared with ideal BMI

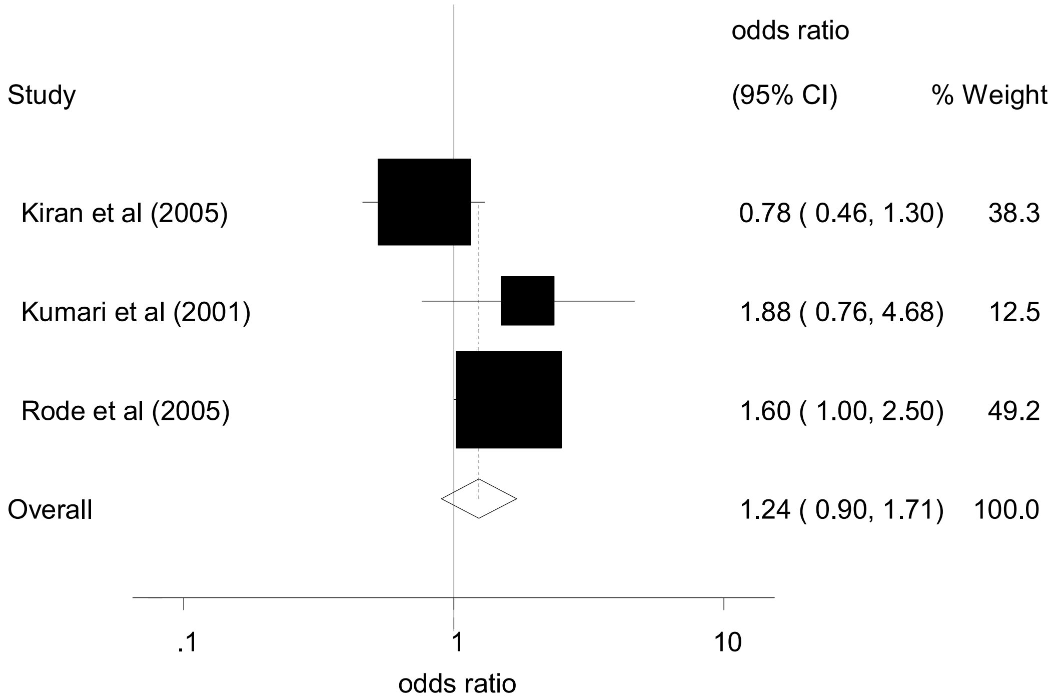


Figure 5: Elective caesarean delivery forest plot for obese BMI compared with ideal and non obese BMI

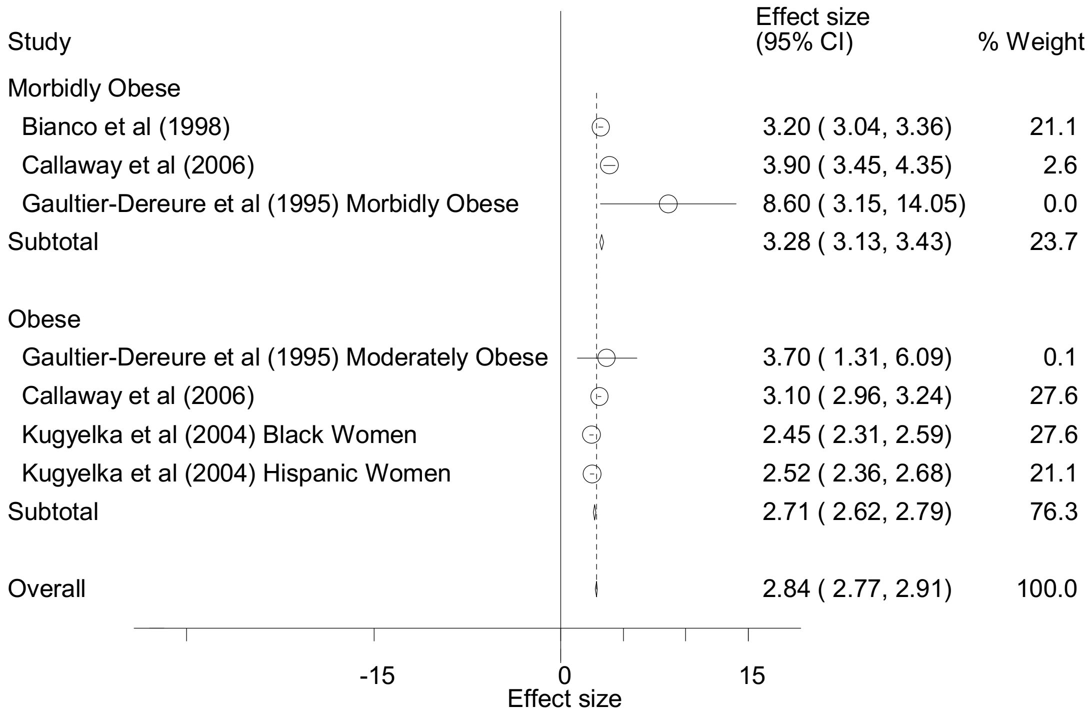


Figure 6: Mean length of hospital stay (days) for obese and morbidly obese BMI compared with ideal BMI (ideal mean length of stay 2.4 days)

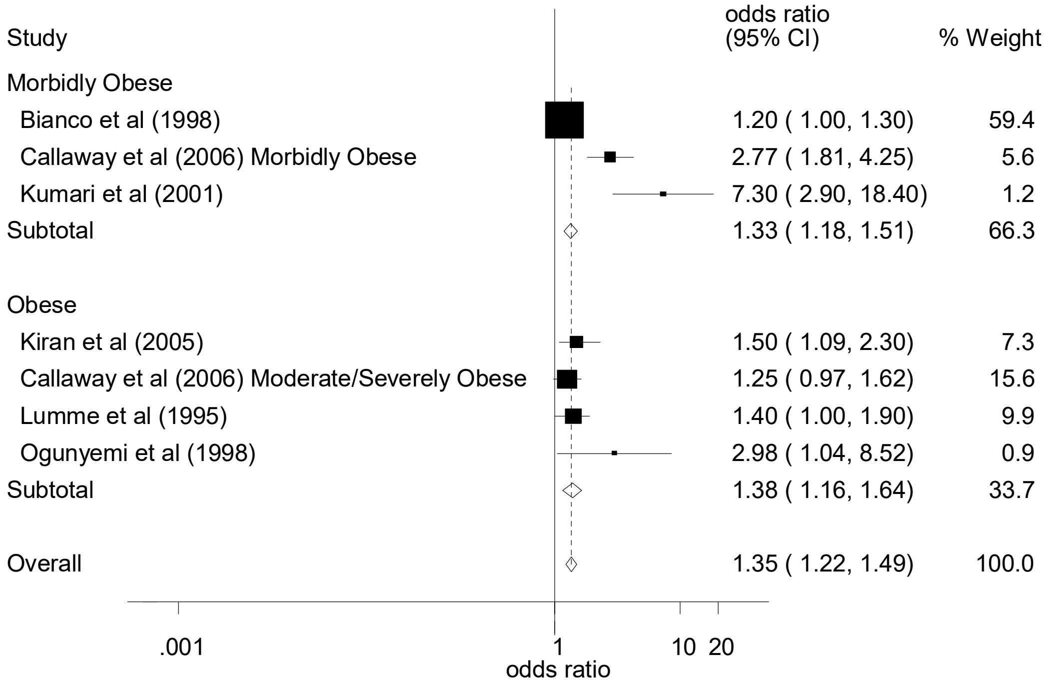


Figure 7: Neonatal intensive care unit treatment for obese and morbidly obese BMI compared with ideal BMI

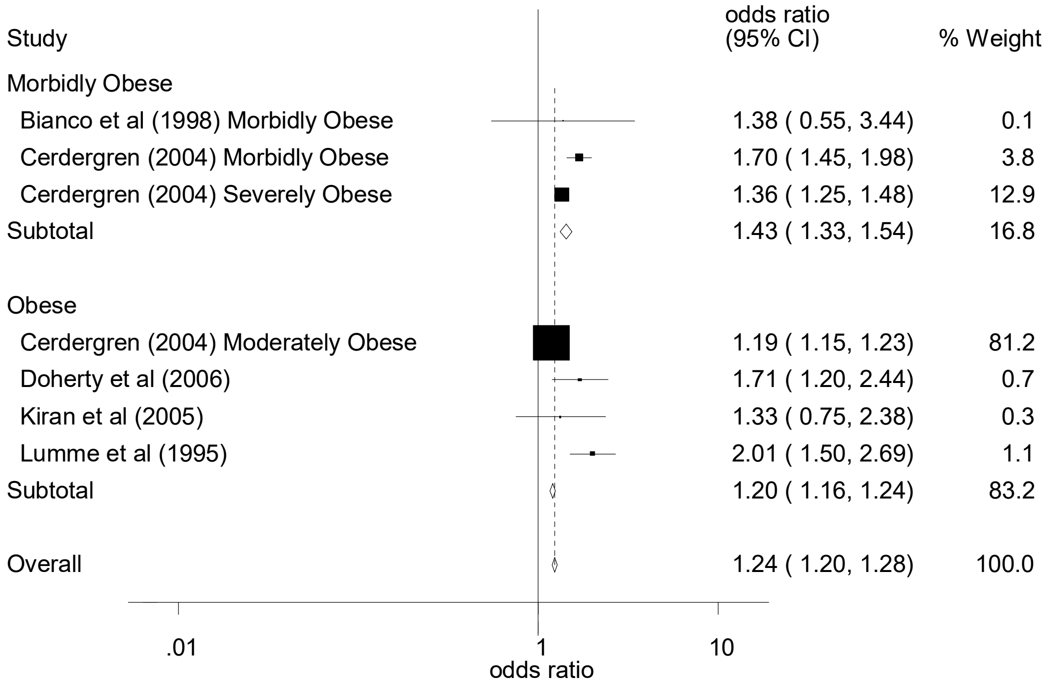


Figure 8: Maternal haemorrhage forest plot for obese and morbidly obese BMI compared with ideal BMI

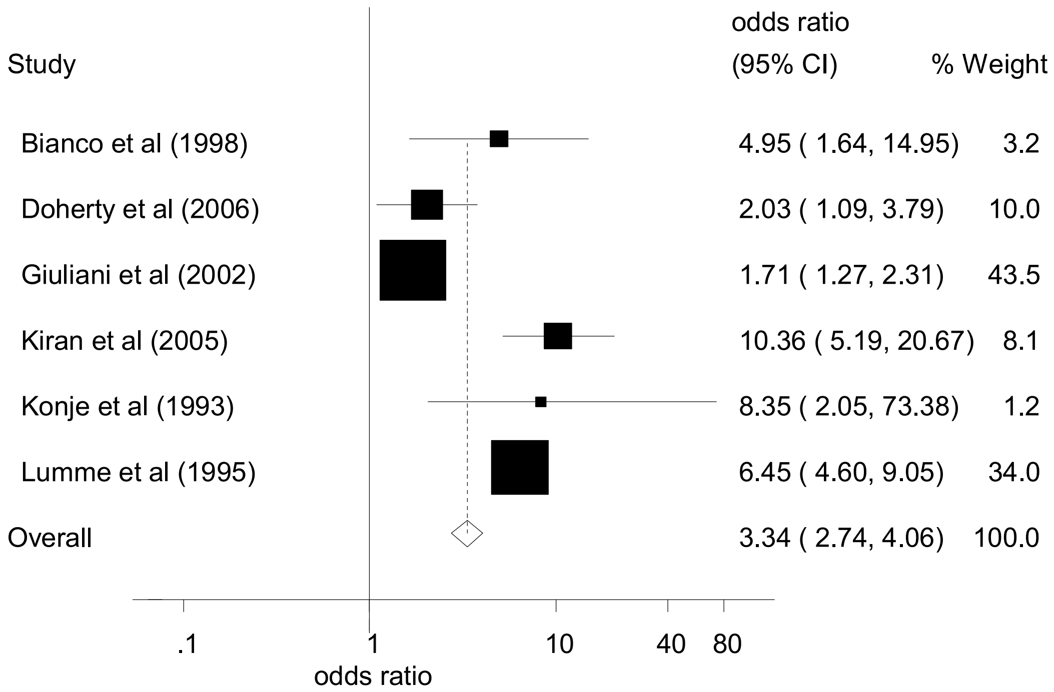


Figure 9: Maternal infection for obese BMI compared with ideal BMI

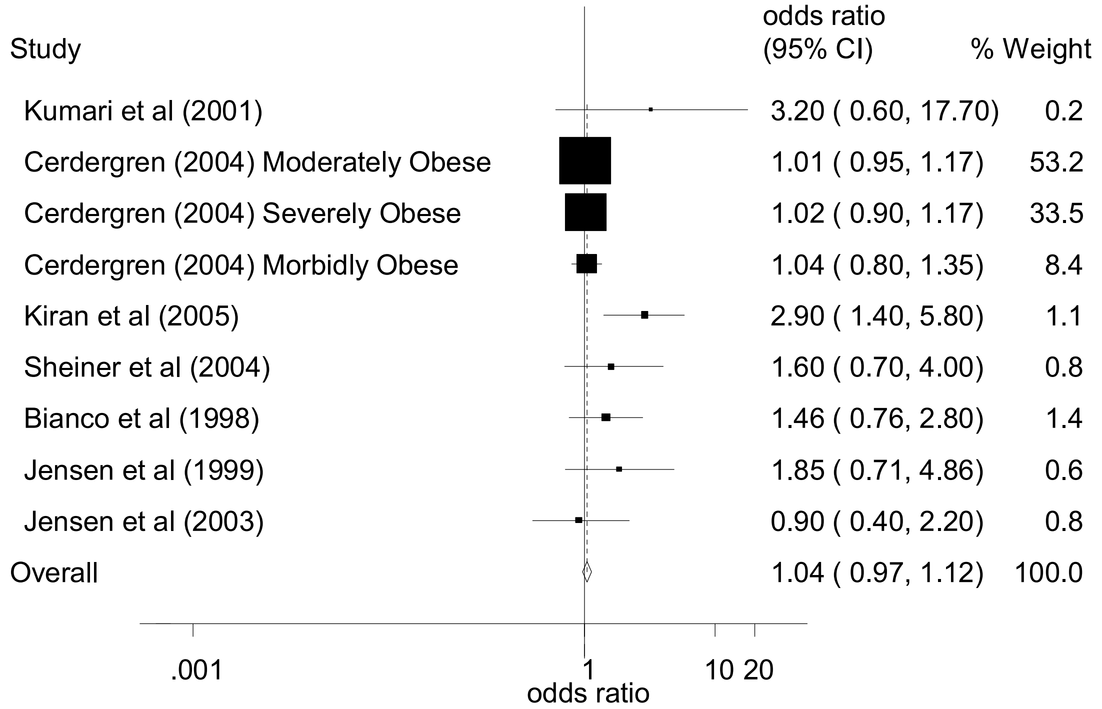


Figure 10: Shoulder dystocia forest plot for obese BMI compared with combined ideal and non obese BMI

Table 1: Characteristics of Included Studies

Paper	Setting	Enrolment Dates/ Recruitment Procedure	Classification Body Weight Status	Control Group	Study Group(s)	Measurement of Weight Status	Exclusions	Ethnic Population	Outcome (Definition)
Abrams and Newman (1991)	USA – San Diego California	January 1978 – December 1988 Prenatal Nutrition Project n= 2,228	% Ideal Body Weight (IBW)	Ideal weight (90-119% ideal) n= 1,352	Under weight (<90% ideal) n= 389 Overweight (120-135% ideal) n= 261 Obese (>135% ideal) n= 226	Pre pregnancy weight based on maternal recall at 1st antenatal visit	Pregnancies complicated by ante partum death, twin gestations, major congenital anomalies	• White (41%) • Hispanic (32%) • Black (15%) • Asian (11%) • Other (<1%)	• Small for gestational age (< 10th percentile of reference standards for birth weight for gestational age and sex in California)
Baeten et al (2001)	USA - Washington	1992-1997 Identified by state birth certificates n= 96,801	BMI (kg/m^2)	Lean (<20) n= 18,988	Normal (20-24.9) n= 50,425 Overweight (25-29.9) n= 17,571 Obese (≥30) n= 9,817	Data taken from Washington state drivers licences for height, and Washington state birth certificates for pre pregnancy weight	BMI not calculable, lost to follow up, multi parous (but included previous termination <20 weeks), multiple gestations, diabetes, hypertensive conditions, non live births	• White (80.8%) • African American (3.1%) • Native American (1.9%) • Asian (6.2%) • Hispanic (6.2%)	• Low birth weight (<2500g) • Macrosomia (≥4000g) • Small for gestational age (<sex specific 10th percentile) • Pre term delivery (<37weeks gestation) • Very pre term delivery (≤32 weeks) • Caesarean delivery
Bergholt et al (2007)	UK - Wycombe General Hospital, Bucks, England	1st Jan 1995 – 31st Dec 2000 Consecutive nulliparous women with a single cephalic presentation and spontaneous onset of labour from 37 to 42 weeks n= 4,341	BMI (kg/m^2)	Ideal (<25) n= 1,179	Overweight (25-30) n= 2,043 Moderately Obese (30-35) n= 859 Severely/ Morbidly Obese (>35) n= 260	Direct weight measurement and self reported height	Multiple gestations, non cephalic presentation, previous pregnancies, non spontaneous labour	• Not stated	• Caesarean delivery total • Caesarean delivery due to fetal distress • Caesarean delivery due to failure to progress
Bianco et al (1998)	USA - New York	1988-1995 Mount Sinai Medical Centre n= 11,926	BMI (kg/m^2)	Normal (19-27) n= 11,313	Morbidly Obese (>35) n= 613	Pre pregnant BMI used	Women aged under 20 and over 34, multiple gestations, missing height or weight data	• White (71.1%) • Non white (28.9%)	• Fetal growth restriction (definition consistent with American College of Obstetricians and Gynaecologists definition) • Placenta previa-abruption • Fetal distress (presence of repeated late decelerations,

									severe variable decelerations, persistent fetal tachycardia, poor beat to beat variability) • Presence of meconium • Failure to progress (arrest of dilation descent, failure to descend, or protracted dilation or descent) • Shoulder dystocia (difficulty delivering the anterior shoulder requiring one or more of the following manoeuvres: suprapubic pressure, hyperflexion of the hips, rotation of the shoulder girdle 180, delivery of the posterior arm, or fracture of the clavicle or humerous) • Pre-term delivery (less than 37 weeks gestation) • Caesarean section • Post-partum haemorrhage (greater than 1000cc of estimated blood loss) • Wound infection • Low Apgar score (< 4 at 1min, < 7 at 5 min) • Birth weight: Low birth weight (< 2500g), Very low birth weight (< 1500g) • Small for gestational age (<10th percentile for age and sex) • Large for gestational age (>90th percentile age and sex according to the Brenner nomogram) • Neonatal intensive care admissions • Hospital stay (mean days)
Bo et al (2003)	Italy - Turin	April 1999-Feb 2001 University of Turin obstetrics and gynaecology department. Women recruited with diabetes and non diabetes as the comparison group. Data extraction for non diabetes only	BMI (kg/m^2)	Normal (20-25) n= 333	Overweight and Obese BMI (>25) n= 117	Pre pregnancy BMI used	Pre existing hypertension, diabetes mellitus, diseases affecting glucose metabolism	Not stated	• Caesarean delivery • Pre term delivery (<37 weeks) • Birth weight (mean) • Large for gestational age (> 90th percentile for northern Italy) • Small for gestational age (<10th percentile for northern Italy)

		n= 450							
Callaway et al (2006)	Australia - Brisbane	1998-2002 Mater Mothers Hospital obstetric database n= 11,252	BMI (kg/m^2)	Normal (20.01-25) n= 6,443	Overweight (25-30) n= 2,882 Obese 30-40 n= 1,679 Morbidly Obese >40 n= 248	Pre pregnancy BMI recorded by recall at the 1st visit, usually before 12 weeks	Underweight women, missing BMI record, emergency and un-booked admissions	• Caucasian (82.0%) • Asian (8.7%) • Aboriginal or Torres Straight Islander (2.2%) • Other (7.0%)	• Birth weight (std deviation z score, corrected for sex and gestation at delivery) • Length of stay (mean in days, and >5 days) • Spontaneous vaginal delivery • Assisted vaginal delivery • Caesarean section • Respiratory distress • Mechanical ventilation • Hypoglycaemia • Jaundice • Phototherapy • Premature (<34 weeks, <37 weeks) • Neonatal intensive care admission
Cerdergren (2004)	Sweden	1992-2001 Identified by the Medical Birth Registry n= 610,969	BMI (kg/m^2)	Normal (19.8-26) n= 526,038	Obese (29.1-35) n= 69,143 Severely Obese (35.1-40) n= 12,402 Morbidly Obese (>40) n= 3,386	Maternal height and weight measured at 10-12 weeks gestation	Insulin dependent diabetes mellitus, multiple gestations, only 1st delivery used if >1 in the study time period, maternal height/weight missing, hypertension	• Caucasian (majority) • South American (1%) • Asian (1.4%) • Sub Saharan African (1%)	• Abruptio placenta • Placenta previa • Caesarean delivery • Instrumental delivery • Anal sphincter laceration (only vaginal deliveries) • Shoulder dystocia (only vaginal deliveries) • Major post partum haemorrhage (only vaginal deliveries) • Epidural anaesthesia (only vaginal deliveries) • Induction of labour • Small for gestational age (<2 SD) • Large for gestational age (>2 SD) • Presence of meconium aspirate • Fetal distress • Low Apgar score (<7 at 5 minutes) • Macrosomia (>4500g) • Gestational age at delivery (42, <37, <32 weeks)
Cnattingius et al (1998)	Sweden	1992 – 1993 Identified via Swedish Medical Birth Register for all infants born in Sweden n= 167,750	BMI (kg/m^2)	Lean (<20) n= 22,634	Normal (20-24.9) n= 101,266 Over weight (25-29.9) n= 33,438 Obese (>30) n= 10,412	Weight recorded by patient recall prior to 15 weeks gestation	Non singleton births, information on pre pregnancy BMI was not available	All mothers born in Sweden, Denmark, Finland, or Iceland. No further details given.	• Preterm delivery (<37 weeks) • Very preterm delivery (≤32 weeks) • Small for gestational age (birth weight >2 SD below mean for GA for Sweden)
Crane et al	USA - New	1994-1995	BMI	Non Obese	Results split	Pre pregnancy	still births, births	• White (control	• Mode of delivery (vaginal,

(1997)	York	Central New York Regional Perinatal Data System [1]Entire sample n= 19,699 [2]Singleton, no prior caesarean n= 16,391	(kg/m^2)	(<29) [1]n= 16,108 [2]n= 13,672	into 2 groups with different BMI categories: Obese (>29) [1]n= 3,591 [2]n= 2,791 ----------------- Obese (29-34.9) [1]n= 2,340 [2]n= 1,819 [2]Severe Obese (35-39.9) [1]n= 813 [2]n= 605 [2]Morbidly Obese (>39.9) [1]n= 438 [2]n= 295	weight and height were self reported	<20weeks gestation, multiple pregnancies, incomplete data	89.6%, obese 89.7%) • Black (control 6.7%, obese, 7.9%) • Other (control 3.7%, obese 2.4%)	caesarean) • Birth weight (mean)
Dempsey et al (2005)	USA – Seattle and Washington	1996 – 2000 Omega Study – women attending prenatal care clinics primarily designed to examine maternal dietary risk factors of preeclampsia and gestational diabetes. Initially included nulliparous, later included multiparous n= 738	BMI (kg/m^2)	Lean (<20) n= 158	Normal (20-24.9) n= 424 Overweight (25-30) n= 103 Obese (>30) n= 53	Data was collected by interview prior to 16 weeks gestation	Lost to follow up, declined to participate, spontaneous abortion, induced abortion, diabetes, missing data, presented >16 weeks, <18years, not able to speak/read English, intended to deliver elsewhere	• White (85.2%) • African American (1.8%) • Asian (7.3%) • Other (5.7%)	• Caesarean delivery • No caesarean • Indication for caesarean: ▪ Fetal position ▪ Cephalopelvic disproportion/ failure to progress ▪ Fetal distress (not defined) ▪ Other (placenta previa, failed induction, placental abruption, active herpes, patient desire, other indications not specified)
Di Cianni et al (1996)	Italy - Pisa	1987-1992 University of Pisa obstetrics and gynaecology computerised data	BMI (kg/m^2)	Normal (<25) n= 44	Overweight (25-30) n= 39 Obese (>30) n= 27	Pre pregnancy BMI used	No gestational diabetes or family history	Not stated	• Gestational age (mean weeks) • Pre term (<38 weeks) • Macrosomia (neonatal size >4kg at 40th week, or >95th percentile – states 95th percentile in the methods and 90th percentile in the

		system. Population selected at random to be a comparison group for women with gestational diabetes mellitus (GDM). Data extraction only for non GDM women n= 110							discussion) • Hyperbilirubinaemia (not defined)
Doherty et al (2006)	USA	Recruitment dates unclear. Data was collected during a randomized controlled trial evaluating the effectiveness of Doppler ultrasound in unselected pregnancies n= 2,769	BMI (kg/m^2)	Normal (18.5-25) n= 1,982	Underweight (<18.5) n= 331 Overweight (25-30) n= 326 Obese (>30) n= 188	Questionnaire completed by research midwives at initial visit (16-20 weeks) and pre-pregnancy BMI was used	Non-singleton gestations, pregnancy loss, missing BMI	• Ethnicity Caucasian (89.92%)	• Labour induction • Caesarean delivery • Caesarean delivery for fetal distress • Postpartum haemorrhage • Perineal trauma • Infection (wound, perineum, urinary tract, chest, breast) • Retained placenta • Intra uterine growth restriction • Neonatal resuscitation
Ehrenberg et al (2004a)	USA - New Orleans	1997-2001 Metrohealth medical centre database n= 12,303	BMI (kg/m^2)	Normal (19.8-25) n= 5,142	Lean (<19.8) n= 1,728 Overweight (25-30) n= 2,828 Obese (>30) n=2,605	Pre natal weight was self reported and height was measured at the initial visit	Multiple gestation, pregnancies not eligible for a trial of labour, delivered <23 weeks, prior caesarean, non vertex presentation, scheduled for elective caesarean, contra indicated for vaginal delivery	• Black (39.9%) No further details given	• Caesarean section • Preterm delivery (<37 weeks) • Term delivery (≥37 weeks) • Labour onset induced • Labour dystocia
Ehrenberg et al (2004b)	USA - New Orleans	1997-2001 Metrohealth medical centre database n= 12,950	BMI (kg/m^2)	Normal (19.8-25) n= 5,391	Lean (<19.8) n= 1,640 Overweight (25-30) n= 2,991 Obese (>30) n= 2928	Pre natal weight was self reported and height was measured at the initial visit	Multiple gestation, non live born, pre term delivery (<37 weeks)	• Black (39%) No further details given	• Large for gestational age (gestational weight >90th percentile for gestational age at the institution of study) • Birth weight (mean and SD)
Ekblad and	Finland	July 1st 1985 (6	Percen	Normal	Overweight	Pre pregnancy	The study	Not stated	• Gestational age (mean weeks)

Grenman (1992)		months) Subjects recruited from the Turku University Central Hospital delivery room log book n= 271	t Ideal Weight for Height (IWH)	weight for height n= 166	(≥20% over IWH) n= 77 Underweight (≤20% under IWH) n= 28	weight used, height measured at delivery	population was selected because of the abnormal pre pregnancy weight or abnormal weight gain (≥20 or ≤5kg) and the next sequential normal weight woman selected		• Birth weight (mean grams) • Induction • Vaginal delivery • Forceps or vacuum (instrumental delivery) • Caesarean (elective, emergency) • Shoulder dystocia • Vaginal repair (2nd, 3rd degree) • Birth weight (weight percentile >90%, <10%) • Apgar score (mean at 1, 5, and 10 minutes) • Admission to neonatal intensive care
Gaultier-Dereure et al (1995)	France - Montpellier	1980-1993 Department of obstetrics & gynaecology, Montpellier Hospital n= 112	BMI (kg/m^2)	Normal (18-24.9) n= 54	Overweight (25-29.9) n= 48 Obese (30-34.9) n= 34 Morbidly Obese (>35) n= 30	Pre gravid weight	Hepatic, cardiac, or renal failure, previous DM, height <145cm, age <18 years	Not stated	• Macrosomia (birth weight >90th percentile for gestational age) • Growth retardation (birth weight <10th percentile for gestational age) • Preterm labour (not defined) • Mean term (weeks) • Duration of labour (hours – overall and primiparous) • Caesarean delivery (overall and 1st caesarean) • Duration of hospitalisation (days – outpatients and inpatients) • Cost of prenatal care (hospitalisation)
Gaultier-Dereure et al (2000)	France - Montpellier	October 1993 – December 1994 Pregnant women seen consecutively at Montpellier Hospital. 54 women had a BMI>26, each paired with a normal weight control n= 84	BMI (kg/m^2)	Normal (18-25) n= 42	Overweight and Obese (>26) n= 42	Pre pregnancy BMI used	Previous diabetes mellitus or severe disease, height <145cm, age <18 years, incomplete hospital records	Not stated	• Day time hospitalisation • Night time hospitalisation
Giuliani et al (2002)	Austria - Graz	1996-2000 Department of obstetrics & gynaecology, Graz n= 11,114	BMI (kg/m^2)	Normal (19.8-26) n= 6,998	Lean (<19.8) n= 2,198 Overweight (26-29) n= 1,025 Obese (≥29)	Pre pregnancy weight was self reported	Deliveries <36 weeks, multiple gestations, non spontaneous delivery, incomplete datasets	• Caucasian (98%) • Asian (1%) • Black (1%)	• Puerperal period complications (occurring between 2 hours after delivery and 42 days post partum) • Urine tract infection (presence of positive urine culture (>1,000,000 micro organisms/ml with or without fever) • Wound infection (pain purulent

					n= 893				drainage from episiotomy, perineal rupture, or laceration site with indurations) • Haemorrhage • Re admission to hospital • Thromboembolic events
Hellerstedt et al (1997)	USA - Minnesota	January 1977 – August 1993 St. Paul-Ramsey Medical Centre deliveries, matched obese with normal weight for ethnicity, delivery date, age, and parity n= 1,343	BMI (kg/m^2)	Normal (19.8-26) n= 660	Obese (>29) n= 683	Pre gravid weight used	Missing data, multiple gestations, fetal deaths	• White (69.0%) • Black (20.5%) • Hispanic (6.6%) • Native American (3.5%)	• Birth weight (mean grams as a continuous variable) • Birth weight as a dichotomous variable (large for gestational age >90th percentile sex specific weight for age, small for gestational age <10th percentile sex specific weight for age) • Mean gestational age at birth • Preterm birth (<37 weeks)
Hendler et al (2005)	USA - Detroit	1992-1994 Preterm Prediction Study n= 2,910	BMI (kg/m^2)	Results split into 2 groups with different BMI categories: [1]Normal (19-24.9) n= not stated [2]Non Obese (<30) n= 2,313	[1]Lean (<19) n= not stated Overweight (25-29.9) n= not stated Obese (30-34.9) n= not stated Morbidly Obese (>35) n= not stated [2]Obese (≥30) n= 597	Pre pregnancy weight used	Multifetal gestation, prenatally detected major fetal abnormalities, history of cervical cerclage in current pregnancy, placenta previa, maternal height and weight data not available	• Black (62.3%)	• Caesarean delivery (group 2) • Birth weight (mean, group 2) • Macrosomia (>4000g, group 2) • Spontaneous preterm birth (SPB <37, <34, <32 weeks, group 2) • Total rate preterm deliveries • Gestational age (mean weeks, group 2) • SPB (<37 weeks, group 1)
Hulsey et al (2005)	USA – South Carolina	1998-1999 Data provided by the Division of Biostatistics, South Carolina Department for Health and Environmental Control. Birth certificate data was linked to the South Carolina Pregnancy Risk Assessment Monitoring System. Women selected	BMI (kg/m^2)	Normal (19.8-26) n= 45,916	Underweight (<19.8) n= 14,141 Overweight (26.1-29.0) n= 10,039 Obese (>29) n= 17,197	Pre pregnant weight used	Multiple gestation, non live birth	• White (56.3%) • Black (43.7%)	• Very low birth weight (500-1499g) • Moderately low birth weight (1500-2499g)

		for the study by a systematic stratified sampling strategy that is weighted on the basis of birth weight n= 87,293							
Jensen et al (1999)	Denmark - Herning	1993-1998 Herning Central Hospital obstetric department n= 4,258	BMI (kg/m^2)	Normal (20-24.9) n= 2,520	Lean (<20) n= 757 Overweight (25-29.9) n= 727 Obese (≥30) n= 254	Pre pregnancy weight and height recorded on the database	Registered complication in an actual pregnancy. Pre or post term delivery, induction of present delivery, non vertex presentation, ante partum fetal death, previous caesarean delivery	Not stated	• Oxytocin • Induced (amniotomy <6cm) • Instrumental delivery (ventouse/forceps) • Caesarean • Episiotomy • Imminent asphyxia • Dysproportion • Primary Inertia • Secondary inertia • Pushing (>1 hour for primiparous, >30 minutes for multiparous) • Shoulder problems • Retained placenta • Perineal rupture • Sphincter rupture • Uterine atony • Bleeding (>499ml) • Occiput posterior • Low birth weight (≤2500g) • Macrosomia (birth weight ≥4500g) • Apgar <7 (5 minutes) (not many outcomes defined)
Jensen et al (2003)	Denmark – Copenhagen, Odense, Aarhus	1992-1996 Recruited women who underwent screening for gestational diabetes mellitus using oral glucose tolerance tests in one of the 4 recruitment centres (Copenhagen County Hospital, Rigshospitalet, Aarhus, and Odense) n= 2,459	BMI (kg/m^2)	Normal (18.5-24.9) n= 1,094	Overweight (25-29.9) n= 728 Obese (≥30) n= 637	Pre pregnancy BMI used	Gestational diabetes, dietary treatment despite normal glucose tolerance test, underweight (BMI <18.5), data height or weight missing, subsequent pregnancies in recruitment time frame, well defined chronic disease, multiple gestations	Not stated	• Macrosomia (birth weight ≥4000g) • Large for gestational age (birth weight in 90th percentile for standard Danish population) • Small for gestational age (birth weight <10th percentile for Danish population) • Caesarean delivery • Induction of labour (% of total excluding elective caesareans), • Respiratory distress (infants with respiratory distress were treated with continuous positive airway pressure for at least 30 minutes) • Shoulder dystocia (additional obstetric manoeuvres required) • Preterm delivery (before 37 weeks) • Hypoglycaemia (need for

									intravenous glucose during 1st 48 hours) • Jaundice
Johnson et al (1992)	USA - Florida	1987-1989 Identified via the maternity units computerised medical record system at the University of Florida department of obstetrics and gynaecology n= 3,191	BMI (kg/m^2)	Lean (<19.8) n= 755	Normal (19.8-26) n= 1,621 Overweight (27-29) n= 329 Obese (>29) n= 486	Self reported pre gravid weight	Pre term delivery (<38 weeks), multiple gestation, fetal abnormalities, oligohydraminos, polyhydraminos, medical or surgical complications, incomplete risk data, incomplete outcome data, stillbirth	• White (58%) • Black (40%) • Other	• Fetal macrosomia (≥4000g) • Low birth weight (<2500g where the risk factor for birth weight <2500, 2500-4000, >4000 was excluded) • Presence of meconium staining • Unscheduled caesarean section • Labour abnormality - (prolonged latent phase, protracted active phase, secondary arrest of dilation, arrest of descent, prolonged second stage) • Fetal compromise/ heart rate abnormality (decreased variability, bradycardia or tachycardia for >10mins, multiple variables, late decelerations) • Newborn resuscitation (artificial ventilation and endotracheal intubation) • Postdates – (gestational age excluded as a risk factor)
Kaiser et al (2001)	USA - Milwaukee	1994-1998 Nurse-midwifery centre, Milwaukee Medical Campus, recruited healthy women undergoing midwife led care n= 1,881	BMI (kg/m^2)	Normal (19.8-26) n= 954	Lean (≤19.7) n= 249 Overweight (26-29) n= 226 Obese (≥29) n= 452	Self reported pre pregnancy weight was used, unless there was a discrepancy then measured before 12 weeks gestation	Chronic conditions (diabetes, hypertension, unstable asthma), prenatal complications (multiple gestation, fetal malformations, gestational diabetes), repeat caesareans (chosen by the mother), missing height and weight data)	• Black (77.1%) • Hispanic (6.6%) • White (14.9%) • Other (1.4%)	• Caesarean delivery
Kiran et al (2005)	UK – Cardiff, Wales	1990-1999 Study population drawn form the Cardiff Birth Survey n= 8,350	BMI (kg/m^2)	Non Obese (20-30) n= 7,673	Obese (≥30) n= 677	Height and weight measured by midwife at booking	Non primigravidas, multiple gestation, non cephalic presentation, <37 weeks gestation, height and weight not measured,	• White (91.5%)	• Macrosomia (>4000g) • Postdates (>41 weeks) • Oxytocin • Labour duration (first stage/second stage, second stage>2hrs) • Mode of delivery (spontaneous vaginal, assisted vaginal, caesarean: emergency/elective,

							congenital abnormalities, pre eclampsia, gestational diabetes mellitus, medical disorders (diabetes, chronic hypertension, cardiac or endocrine disorders, and surgical conditions), BMI<20		induced, not induced, failed instrumental) • Blood loss (>500mL – postpartum haemorrhage as defined by WHO) • Transfusion • Uterine and wound infection • Perineal tear ($3^{rd}/4^{th}$ degree) • Apgar at 5 minutes (<7) • Asphyxia (based on clinical impression of the infant including Apgar score, respiratory difficulty, blood pressure, pulse, muscle tone and coma if present) • Trauma (cuts, grazes, bruises, fractures, muscle haematomas, dislocation, cephalhaematomas, nerve palsies) • Shoulder dystocia • Neonatal unit admissions • Cord (pH < 7.2) • Tube feeding • Incubator requirement • Urine tract infection • Evacuation Uterus
Konje et al (1993)	UK - Hull	January 1989 – June 1990 Women who booked before 16 weeks gestation at Hull Maternity Hospital, and were obese were matched with non obese women n= 862	Percent Ideal Weight for Height (IWH)	Non obese n= 354	Obese (>130 IWH for Hull population) n= 508	Women weighed and categorised into obese and non obese using data from Hull Maternity Unit to define cut offs. 750 women were randomly sampled at <16 weeks gestation, between Sept - Dec 1988. Data plotted to make a nonogram for the Hull population	Booking gestation >16 weeks	Not stated	• Difficulty determining fetal lie • Ante partum haemorrhage • Premature rupture of membranes • Preterm labour (<37 weeks) • Prolonged pregnancy (>42 weeks) • Birth weight (mean) • Macrosomia (>4000g) • Onset of labour (spontaneous or induced) • Instrument delivery (forceps) • Caesarean delivery (total, elective) • Epidural analgesia • Duration of labour (hours) • Blood loss (mean) • Retained placenta • Perineal wound infection • Abdominal wound infection
Kramer et al (1999)	Canada - Montreal	1978-1996 Royal Victoria Hospital computerised	BMI (kg/m^2)	Normal (19.8-26) n= 22,819	Lean (<19.8) n= 9,179 Over weight (26-29)	Pre pregnant BMI used	Multiple gestations, congenital abnormalities	Not stated (ethnically diverse population)	• Intrauterine growth restriction (No IUGR = Birth Weight Ratio of ≥ 0.85, Mild IUGR= BWR of ≥0.75-<0.85, Severe IUGR = BWR of <0.75)

		obstetric and neonatal database n= 37,164			n=,2,750 Obese (≥29) n= 2,416				• Intrauterine growth restriction at term (≥37 completed weeks gestation) • Intrauterine growth restriction preterm (<37 completed weeks gestation)
Kugyelka et al (2004)	USA – New York	1998-2000 (Hispanic group) 1999-2000 (Black group) Community based study reviewing medical records and information in the perinatal database at 2 hospitals in upstate New York Black n= 640 Hispanic n= 587	BMI (kg/m^2)	Black: Normal (19.1-26.0) n= not stated Hispanic: Normal (19.1-26.0) n= not stated	Black: Overweight (26.1-29) n= not stated Obese (>29.1) n= not stated Hispanic: Overweight (26.1-29) n= not stated Obese (>29.1) n= not stated	Pre pregnancy BMI	Multiple gestation, preterm birth, BMI unobtainable, lost to follow up, death in infancy, stay in hosp ≥7 days (mother or baby), Neonatal intensive care, cleft lip and palate, Neural tube defects, discharged to foster care/ adoption, maternal diabetes or serious medical conditions	• Hispanic (47.8%) • Black (52.2%)	• Birth weight (g) • Age of infant at discharge (days – used as length of stay data) • Apgar at 5 minutes (continuous score)
Kumari et al (2001)	Abu Dhabi	1996-1998 Women who attended the Al-Mafraq hospital within the 1st 12 weeks of pregnancy and weighed >90kg had their BMI measured, matched for age and parity with non obese controls. Data retrieved from the delivery room records and prospectively entered into computerised forms n= 488	BMI (kg/m^2)	Non obese (22-28) n= 300	Morbidly Obese (≥40) n= 188	Measured height and weight within 12 weeks of pregnancy	Chronic hypertension or diabetes, didn't attend antenatal clinic within 12 weeks	Not stated	• Placental previa • Abruption • Caesarean section (elective, emergency, and total) • Shoulder dystocia • Preterm labour • Intrauterine growth restriction • Low birth weight (<2500g) • Macrosomia (birth weight >4000g) • Low Apgar (<7 at 1 minute) • Neonatal intensive care admission
Lombardi et al (2005)	USA - Kentucky	1990-2000	BMI (kg/m^2)	Normal (20-25)	Obese (≥30) n= 365	Pre pregnancy BMI used	Patients with associated	• White (80.8%)	• Abruptio placenta • Caesarean delivery

		Patients enrolled in an outpatient management programme, normal weight pregnant women with mild gestational hypertension matched with obese for gestational age at diagnosis, race and parity n= 730		n= 365			medical problems, fetal compromise, rupture of membranes		• Pre term (<34 weeks) • Birth weight (mean) • Low birth weight (<2500g) • Very low birth weight (<1500g)
Lumme et al (1995)	Finland	1985-1986 University of Oulu n= 9,015	BMI (kg/m^2)	Normal (19-24.9) n= 6,437	Lean (<19) n= 992 Overweight (25-29.9) n= 1,235 Obese (≥30) n= 352	Pre pregnancy body weight was self reported, then checked at the first antenatal visit	Multiple pregnancies, missing height and weight data	Not stated	• Preterm delivery (<37 weeks) • Post term delivery (>41 weeks) • Small for gestational age (birth weight <10th percentile for gestational age for the same cohort) • Large for gestational age (birth weight >90th percentile for gestational age based on the same cohort) • Low birth weight (<2500g) • Macrosomia (≥4500g) • Low Apgar score (<7) • Neonatal intensive care • Hospital admission during pregnancy • Labour induction • Non spontaneous delivery (induced labour and those delivered by elective caesarean) • Caesarean section • Intra-operative haemorrhage (>1000ml in caesarean deliveries) • Post operative maternal morbidity (total) • Wound infection
Mancuso et al (1991)	Italy	Dates of enrolment not stated. Pregnant women admitted to the Institute of Gynaecology of the Messina University with a gestational age of 34-42 weeks	BMI (kg/m^2)	Non Obese (<30) n= 90	Obese (≥30) n= 70	Pre pregnant BMI used	Gestational age <34 or >42 weeks	Not stated	• Gestational age at delivery (<37, 38-41, >42 weeks) • Spontaneous delivery • Caesarean delivery • Iterative caesarean section • Instrumental delivery (forceps) • Low birth weight (<2500g) • Macrosomia (birth weight >4000g) • Apgar score at 1 minute (<7, >7)

		recruited into the study n= 140							• Puerperium complications (pyrexia, haemorrhage, uterine sub-involution)
Naeye (1990)	USA – 12 medical school-affiliated hospitals in different regions of the USA	1959-1966 Collaborative Perinatal Study (CPS) of the Neurological and Communicative Disorders and Stroke. Prospectively follows children from before birth to 7 years n= 55,665 singletons n= 598 twins	BMI (kg/m^2)	Lean (<20) n= 12,669	Normal (20-24) n= 28,810 Overweight (25-30) n= 10,160 Obese (>30) n= 5,218	Pre gravid BMI used, maternal height was measured and pre gravid weight was self reported at the first antenatal clinic visit	Women who delivered at a non CPS hospital	• Black (46.3%) No further details specified	• Premature (24-30 weeks, 31-37 weeks) • Birth trauma (skull fracture) • Neonatal respiratory distress syndrome (not defined)
Nucci et al (2001)	Brazil	1991-1995 Prenatal clinics in 6 state capitals n= 5,314	BMI (kg/m^2)	Normal (18.5-24.9) n= 3,583	Lean (<18.5) n= 309 Overweight (25-29.9) n= 1,086 Obese (≥30) n= 336	Pre pregnancy weight used by maternal recall. Height was measured in duplicate	Diabetic women, age <20, missing data to calculate BMI	• White (45.2%) • Mixed Race (41.4%) • Black (13.4%)	• Large for gestational age (birth weight ≥ 90th percentile for gestational age of the study sample) • Microsomia (birth weight ≤ 10th percentile for gestational age of the study sample) • Gestational age (hierarchal criteria based on 4 clinical examinations)
Ogunyemi et al (1998)	USA - New Jersey & Alabama	1990-1995 Women who registered for prenatal care in the 1st trimester at Morristown Memorial Hospital, predominantly a rural black population n= 582	BMI (kg/m^2)	Normal (19.8-26) n= 223	Lean (<19.8) n= 78 Overweight (26-29) n= 78 Obese (≥29) n= 203	Pre pregnancy weight and height self reported at 1st visit, measured in 1st trimester, women wearing light clothes and no shoes	Multiple gestation, >37 weeks gestation at delivery, self reported height and weight if difference between measured weight >10%, not low income women, registration for prenatal care not in 1st trimester	• Black (100%)	• Low birth weight (<2500g) • Birth weight (mean and SE) • Neonatal intensive care • Caesarean delivery
Olesen et al (2006)	Denmark	1998-2001 Data retrieved from the Danish Birth Cohort which is a	BMI (kg/m^2)	Normal (20-24) n= 26,468	Underweight (<20) n= 7,918 Overweight	Interviewed at 12 weeks and asked for pre-pregnancy BMI	Women who could not speak Danish well enough or those without access to	• Not stated	• Post term delivery (>42 weeks)

		follow up study that recruited 100,000 pregnant women in Denmark from 1996-2004 n= 48,064			(25-30) n= 9,201 Moderately Obese (30-34) n= 2,713 Severely/ Morbidly Obese (>35) n= 1,020		a phone, multiple gestations, non live birth		
Phithakwa-tchara and Titapant (2007)	Bangkok, Thailand	Jan 2003 to Dec 2005 Retrospective review using medical records of pregnant women who received prenatal care and delivered at the Siriraj Hospital. All women in the study were at risk of gestation diabetes mellitus n= 660	BMI (kg/m^2)	Normal (20-25) n= 330	Obese (≥27) n= 330	Pre pregnancy BMI from medical records	Those women without pre pregnancy weight status recorded, multiple gestation, pre-existing chronic illness, planned elective CD, no non cephalic presenting pregnancies	• Not stated	• Pre term delivery (<37 weeks) • Caesarean delivery (non planned) • Macrosomia (>4000g) • Low birth weight (not defined) • Neonatal Jaundice (requiring phototherapy) • Hypoglycaemia (requiring intravenous glucose in 1st 48 hours) • Shoulder dystocia
Ranta et al (1995)	Finland	1992 (3 month period) University of Oulu n= 662	BMI (kg/m^2)	Normal (20-24.9) n= 609	Obese (≥30) n= 53	Pre pregnancy BMI recorded from measured height and self reported weight at 1st antenatal visit (7-12 weeks)	Scheduled caesarean deliveries	Not stated	• Pain intensity (in delivery room, 11 point visual scale where 0 is no pain and 10 is worst pain) • Vaginal delivery • Induced • Instrumental delivery (vacuum extraction) • Caesarean delivery: emergency • Duration of labour (1st and 2nd stage) • Epistiotomy • Vaginal repair • Analgesia (none, epidural, paracervical block, nitrous oxide, pethidine) • Birth weight (mean) • Apgar score (median at 1, 5, and 15 minutes) • Intubation • Neonatal intensive care admission
Rantakallio	Finland	1985-1986	BMI	Normal (20-	Lean (<20)	Pre pregnancy	Unknown height /	Not stated	• Preterm birth (<37th full

et al (1995)		University of Oulu n= 9,243	(kg/m^2)	24.9) n= 5,357	n= 2,161 Overweight (25-29.9) n= 1,254 Obese (30-35) n= 283 Morbidly Obese (>35) n= 73	weight used	weight		gestational week) • Low birth weight (<2500g) • Small for gestational age (birth weight <10th percentile for gestational age specific percentile curve)
Rode et al (2005)	Denmark	1998-2001 Copenhagen First Trimester Study, Gestational age <15 weeks at enrolment n= 8,092	BMI (kg/m^2)	Normal (<25) n= 6,350	Overweight (25-29.9) n=1,298 Obese (≥30) n= 444	Pre pregnancy BMI recorded prior to 15 weeks gestation	Multiple gestation, non cephalic delivery, delivery <37 weeks, missing BMI record, miscarriage	Not stated	• Premature rupture of membranes • Placental abruption • Caesarean delivery (overall, emergency, elective) • Instrumental delivery (vacuum extraction) • Shoulder dystocia • Perineal rupture (3rd/4th degree) • Preterm delivery (<37 weeks) • Post term (>42 weeks) • Low umbilical cord pH (<7) • Low Apgar score (<7 at 5 minutes) • Birth weight (<2500g and >3999g)
Rosenberg et al (2003)	USA – New York	1998-1999 Birth certificate data from the New York City Department of Health, Office of Vital Statistics and Epidemiology n= 213,208	Weight (lbs/kg)	100-149lbs / 45-67kg n=135,932	≤99lbs / 45kg n= 6,206 150-199lbs / 68-90kg n= 57,758 200-299lbs / 91-135kg n= 12,897 ≥300lbs / 136kg n= 415	Pre pregnancy weight identified via birth certificates (BMI could not be calculated as the birth certificates do not record maternal height)	Missing weight data, multiple gestation, non live births	• White (29.5%) • Black (27.6%) • Hispanic (32.2%) • Asian/other (10.7%)	• Caesarean delivery • Very low birth weight (<1500g) • Macrosomia (≥4000g) • Neonatal intensive care admission
Rossner and Ohlin (1990)	Sweden	Dates of enrolment not defined. The Stockholm Pregnancy and Weight Development Study n= 1,423	BMI (kg/m^2)	Lean (<20) n= 657	BMI (20.0 - 23.9) n= 1,326 BMI (24-25.9) n= 174 Over weight / Obese (>26) n= 127	Pre pregnancy self reported body weight was retrieved from the maternity unit standardised chart	Twin deliveries, serious complications, women who withdrew at 6 month and 12 month follow up	Not stated	• Birth weight • Mode of delivery (vaginal, caesarean)

Sheiner et al (2004)	Israel - Negev	1988-2002 Soroka Medical Centre computerised medical records n= 126,080	BMI (kg/m^2)	Non obese (BMI not stated assume <30) n= 124,311	Obese (≥30) n= 1,769	Pre pregnant BMI used	Hypertension, gestational and pre gestational diabetes, patients lacking pre natal care (less than 3 visits)	• Jewish (54.9%) • Bedouins (45.1%)	• Macrosomia • Previous caesarean delivery • Caesarean delivery • Labour induction • Placental abruption • Placenta previa • Failure to progress (1st and 2nd stage) • PROM • Meconium stained amniotic fluid • Mal presentation • Low Apgar score (1 minute and 5 minute <7) • Shoulder dystocia • Post partum haemorrhage • Packed cells transfusion • Peripartum fever • Low birth weight (<2500g)
Shepard et al (1998)	USA - New Haven (Yale)	1988-1992 Yale - New Haven Hospital, privately insured women only n= 2301 or 2714, details unclear	BMI (kg/m^2)	Low average (19.5-22.4) n= not stated	Underweight (<19.4) n= not stated High average (22.5-28.5) n= not stated Obese (>28.5) n= not stated	Pre pregnancy weight recorded at initial interview less than 16 weeks gestation	Multiple gestation, missing BMI data, mode of delivery data not available, repeat caesarean, GDM, not privately insured	• White (90.8%) • Black (5.0%) • Asian (2.5%) • Hispanic (1.1%) • Other (0.5%)	• Mode of delivery (caesarean and vaginal)
Steinfeld et al (2000)	USA - Connecticut	1994-1997 Hartford Hospital Department of Obstetrics and Gynaecology computerised records n= 2,424	BMI (kg/m^2)	Non obese (BMI not stated assume <29) n= 2,256	Obese (>29, if BMI not available weight of 200lbs or more) n= 168	Pre pregnancy weight used	Not stated	• Hispanic (65.8%) • African American (16.8%) • White (13.7%) • Asian (1.4%) • Mixed/Other (2.3%)	• Fetal macrosomia (≥4500g) • Caesarean delivery (excluded caesarean delivery for fetal mal presentation, placenta previa or patient request) • Operative/instrumental vaginal delivery (including vacuum assisted and forceps delivery)
Vahratian et al (2004)	USA - North Carolina	1995-2000 Pregnancy, Infection, and Nutrition study n= 612	BMI (kg/m^2)	Normal (19.8-26) n= 297	Overweight (26-29) n= 115 Obese (>29) n= 200	Self reported pre pregnancy weight, 1st measured weight @ booking <16wks, measured height at booking	Term status misclassified, nulliparity misclassified, patient charts not located, elective caesarean, <16 years, multiple gestation, non English speaker, no telephone access, prenatal	• White (53.9%) • African American (39.7%) • Other (6.4%)	• Macrosomia (not defined) • Birth weight (mean, SD) • Method Membrane Rupture (spontaneous, artificial/induced, undetermined) • Spontaneous vaginal delivery • Instrument-assisted vaginal delivery • Primary emergent caesarean • Indications for primary caesarean (failure to progress, mal

							visit not before study enrolment, planned to be delivered at non study hospitals, multiparous, pre pregnancy BMI<19.8		presentation, fetal distress, placental abruption, failed induction, failed forceps / vacuum delivery, other factor) • Oxytocin • Epidural
Weiss et al (2004)	USA - New York	Enrolment dates not stated FASTER Trial: multi centre study designed to assess down syndrome risk n= 16,102	BMI (kg/m^2)	Non Obese (<30) n= 13,752	Severely Obese (30-34.9) n= 1,473 Morbidly Obese (>35) n= 877	Self reported weight and height at 1st visit (enrolled at 10-14 weeks gestation)	Multiple gestation, incomplete records (Caesarean delivery – nulliparous women only as data on previous caesarean delivery was not available)	• White (70.9%) • American Indian (0.6%) • Asian (3.5%) • African American (4.8%) • Hispanic (19.5%) • Other (0.6%)	• Caesarean delivery (total rate amongst nulliparous) • Operative vaginal delivery (% of all except elective caesareans, forceps or vacuum assisted) • Pre term delivery (<37 weeks) • Pre term premature rupture of membranes (<37 weeks) • Intrauterine growth restriction (estimated fetal weight by ultrasound below 10th percentile or birth weight below the 10th percentile for gestational age) • Birth weight (>4000g, and >4500g) • Placenta previa (placenta completely or partially covering the internal os) • Placental abruption (premature separation of a normally implanted placenta)
Yekta et al (2006)	Iran, Urmia	2002 and 2003 Prospective cross sectional study recruiting women who enrolled in public health care centres in urban areas of Urmia n= 270	BMI (kg/m^2)	Normal (19.8-26) n= 140	Underweight (<19.8) n= 30 Overweight (26-29) n= 52 Obese (>29) n= 48	Baseline weight and height recorded during first visit, pre pregnancy weight based on measure weight in first 2 months of pregnancy	Preterm delivery (<37weeks), Low birth weight (<2500g) and c-section, Women with uncomplicated pregnancies that did not include: preeclampsia, twin gestation, history of diabetes, cardiovascular and kidney diseases	• Not stated	• Birth weight (mean) • Low birth weight • Preterm • Caesarean section

Table 2: Quality Score and Statistical Adjustments for Included Studies

Paper	Quality Score	Results*	Adjustments
Abrams and Newman (1991)	-	OR AOR (low birth weight for under weight only)	 Multiple logistic regression and backwards elimination
Baeten et al (2001)	++	AOR	Age, smoking, weight gain, marital status, education, trimester pre natal care, payer prenatal care, plus excluded diabetes and hypertension
Bergholt et al (2007)	+	AOR	Age, gestational age, birth weight, height, oxytocin use, epidural
Bianco et al (1998)	+	ORC (fetal growth retardation, shoulder dystocia, preterm delivery, post partum haemorrhage, wound infection, low apgar score, low birth weight, very low birth weight, small for gestational age) AOR 1. placenta previa-abruption, fetal distress, meconium, failure to progress, neonatal intensive care unit 2. caesarean delivery 3. large for gestational age	1. Ethnic origin, parity, substance abuse, clinic service, pre existing medical condition 2. As 1 plus controlled for macrosomia 3. As 1 plus controlled for gestational diabetes
Bo et al (2003)	+	ORC	None
Callaway et al (2006)	++	AOR (caesarean delivery, jaundice, preterm, admission to intensive care, length of stay more than 5 days) ORC (vaginal delivery, respiratory distress, mechanically ventilated, phototherapy)	Age, ethnic group, parity, smoking, education
Cerdergren (2004)	++	AOR	Age, parity, smoking, year of birth, maternal education (only available for 1992-1995), excluded pre-exist hypertension and insulin dependent diabetes mellitus
Cnattingius et al (1998)	+	AOR	Age, parity, smoking, education, height, living with father, weight gain
Crane et al (1997)	+	AOR	Age, parity, hypertension, diabetes, birth weight, excluded multiple gestations and prior caesarean
Dempsey et al (2005)	-	AOR	Age, ethnic group, height, excluded pre eclampsia and gestational diabetes
Di Cianni et al (1996)	-	ORC	None
Doherty et al (2006)	++	AOR	Adjusted for all statistically significant confounders such as age and parity, but detail on adjustments for each variable are not given

Ehrenberg et al (2004a)	+	ORC (induction and macrosomia) OR (overall caesarean	 Univariate analysis
Ehrenberg et al (2004b)	+	AOR	Ethnic group, parity, newborn gender, only included term deliveries
Ekblad and Grenman (1992)	-	ORC	None
Gaultier-Dereure et al (1995)	-	ORC	None
Gaultier-Dereure et al (2000)	+	AOR	Matched for age and parity, sum of the duration of night time and corrected daytime hospitalisation, correcting coefficient 0.766 daytime, 1.40 night time
Giuliani et al (2002)	-	ORC	None
Hellerstedt et al (1997)	+	ORC	Matched for race/ethnicity, delivery date, age, and parity
Hendler et al (2005)	+	ORC (macrosomia, caesarean delivery) AOR (preterm delivery)	 Age, ethnic origin, parity, previous spontaneous preterm birth, bacterial vaginosis, fetal fibronectin, cervical length at 23-24 weeks gestation, education
Hulsey et al (2005)	-	AOR	Ethnicity, intendedness of pregnancy, Medicaid status, WIC status, prenatal care utilisation, diabetes, hypertension
Jensen et al (1999)	-	ORC	None
Jensen et al (2003)	+	OR (small for gestational age, shoulder dystocia, preterm delivery, hypoglycaemia, jaundice) AOR 1. large for gestational age, macrosomia 2. induction of labour, caesarean	1. Age, ethnic group, parity, smoking, gestational age, weight gain, glucose tolerance, clinical centre, screening indicators for gestational diabetes (family history diabetes, >20% pre pregnancy overweight, previous unexplained still birth, previous macrosomic infant >4500g, age >35, gestational diabetes in previous pregnancy, glucosuria) 2. All adjustments plus excluded women with hypertensive complications
Johnson et al (1992)	++	AOR	All term deliveries, age, ethnicity, parity, smoking alcohol drug, post date, weight gain, pre-pregnancy weight, height, married, fetal gender, diabetes, maternal education
Kaiser et al (2001)	++	AOR	Age >35years, maternal race black, parity, primi gravidity, weight gain, marital status, very low birth weight, height (short stature), failure to progress, breech, placental abruption, fetal brachycardia, severe pre eclampsia
Kiran et al (2005)	+	ORC	None
Konje et al (1993)	-	OR	Matched for gestational age, socio economic status, age, parity
Kramer et al (1999)	+	AOR	Age, parity, smoking, weight gain, marital status, education, hypertension, height, diabetes
Kugyelka et al (2004)	++	ORC	None
Kumari et al (2001)	+	OR (pre term, shoulder dystocia, low birth weight, placenta abruption and previa, intra	Matched for age, parity, gestational age,

		uterine growth retardation) AOR (caesarean delivery, macrosomia, apgar score, neonatal intensive care)	 Matched plus excluded gestational diabetes and pregnancy induced hypertension
Lombardi et al (2005)	-	ORC	Matched for gestational age, ethnic group, parity
Lumme et al (1995)	++	ORC (hospital admission during pregnancy, induction, caesarean delivery, intra operative haemorrhage, post operative maternal morbidity, wound infections) AOR (preterm and post date delivery, small for gestational age, large for gestational age, low birth weight, macrosomia, apgar score, neonatal intensive care)	 Age, parity, smoking, education, only extracted data on women without complications (i.e. without diabetes mellitus, gestational diabetes, gestational or chronic hypertension, pre-eclampsia)
Mancuso et al (1991)	-	ORC	None
Naeye (1990)	-	ORC	None
Nucci et al (2001)	-	OR	None
Ogunyemi et al (1998)	-	ORC	Ethnic group – black women only, low income, rural population
Olesen et al (2006)	+	AOR	Maternal age, parity
Phithakwatchara and Titapant (2007)	-	AOR	Weight gain, screening indicators for gestational diabetes, excluded pre existing chronic illness (hypertension, diabetes mellitus, HIV)
Ranta et al (1995)	-	ORC	None
Rantakallio et al (1995)	+	ORC from data provided on incidence per 1000	Confounders identified as age group, parity, smoking, fathers social class, area of residence (urban v's rural), marital status. Confounder score attached to each and used as a categorical covariate in subsequent modelling.
Rode et al (2005)	+	OR (preterm and post date delivery) AOR 1. Caesarean delivery (overall) 2. Emergency caesarean, vacuum extraction 3. Elective caesarean 4. Low birth weight 5. High birth weight	 1. Age, assisted reproduction, pre eclampsia, macrosomia, diabetes 2. Age, pre eclampsia, macrosomia 3. Age, assisted reproduction, macrosomia 4. Pre eclampsia 5. Gestational age >42 weeks
Rosenberg et al (2003)	++	AOR 1. Caesarean delivery 2. Low birth weight,	 1. Age, ethnic group, parity, smoking, marital status, education, prenatal care, infant gender, social risk, care payer

		high birth weight, neonatal intensive care unit	2. As above plus excludes chronic diabetes, GDM, chronic high blood pressure, pregnancy induced hypertension, pre eclampsia, eclampsia
Rossner and Ohlin (1990)	-	ORC	None
Sheiner et al (2004)	-	OR (induction, placental abruption and previa, failure to progress 2nd stage, meconium stained amniotic fluid, caesarean delivery, Apgar scores, shoulder dystocia, postpartum haemorrhage) AOR (failure to progress 1st stage, malpresentation, macrosomia, premature rupture of membranes)	 Multivariable logistic regression with backward elimination
Shepard et al (1998)	+	ORC	None
Steinfeld et al (2000)	-	ORC	None
Vahratian et al (2004)	-	ORC	None
Weiss et al (2004)	++	AOR	Age, ethnic origin, parity, gestational age, education, marital status, birth weight, assisted reproductive technology
Yekta et al (2006)	-	ORC	None

* OR: Crude Odds Ratio
AOR: Adjusted Odds Ratio
ORC: Odds Ratio Calculated for review

Table 3: Results of Included Studies - Obese: Labour and Delivery 1

Paper	Labour Onset: Spontaneous		Labour Onset: Induced		Labour Onset: Failed Induction		Caesarean Delivery: Total		Caesarean Delivery: Emergency		Caesarean Delivery: Elective		Vaginal Delivery		Instrumental Delivery		Failed Instrumental Delivery		Oxytocin		Failure to Progress	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Baeten et al (2001)	–	–	–	–	–	–	2.7	2.5 2.9	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bergholt et al (2007)	–	–	–	–	–	–	a/b 1.9 c 3.8	a/b 1.3 2.8 c 2.4 6.2	–	–	–	–	–	–	–	–	–	–	–	–	a/b 1.6 c 3.3	a/b 1.0 2.7 c 1.9 5.9
Bianco et al (1998)	–	–	–	–	–	–	b/c 2.3	b/c 1.9 2.8	–	–	–	–	–	–	–	–	–	–	–	–	b/c 2.6	b/c 2.0 3.5
Bo et al (2003)	–	–	–	–	–	–	1.4	0.9 2.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Callaway et al (2006)	–	–	–	–	–	–	a/b 2.0 c 2.5	a/b 1.8 2.3 c 1.9 3.3	–	–	–	–	a/b 0.7 c 0.5	a/b 0.6 0.7 c 0.4 0.7	a/b 0.6 c 0.4	a/b 0.5 0.8 c 0.2 0.8	–	–	–	–	–	–
Cerdergren (2004)	–	–	a 1.8 b 2.3 c 2.5	a 1.7 1.8 b 2.2 2.4 c 2.3 2.8	–	–	a 1.2 b 1.2 c 1.3	a 1.1 1.2 b 1.1 1.3 c 1.2 1.6	–	–	–	–	–	–	a 1.2 b 1.2 c 1.3	a 1.1 1.2 b 1.1 1.3 c 1.2 1.6	–	–	–	–	–	–
Crane et al (1997)	–	–	–	–	–	–	1.6	1.5 1.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dempsey et al (2005)	–	–	–	–	–	–	2.7	1.5 4.9	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Doherty et al (2006)	–	–	2.4	1.7 3.5	–	–	2.4	1.7 3.5	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ehrenberg et al	–	–	1.8	1.6	–	–	2.0	1.7	–	–	–	–	–	–	–	–	–	–	–	–	–	–

(2004a)				2.1				2.4														
Ekblad & Grenman (1992)	–	–	23.1	7.7 69.2	–	–	–	–	2.9	0.8 10.2	1.2	0.5 3.1	1.4	0.8 2.7	0.3	0.0 2.1	–	–	–	–	–	–
Gaultier-Dereure et al (1995)	–	–	–	–	–	–	a 1.7 b/c 7.5	a 0.5 6.3 b/c 2.3 24.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hendler et al (2005)	–	–	–	–	–	–	3.4	2.7 4.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jensen et al (1999)	–	–	2.8	1.9 4.0	–	–	1.7	0.9 3.0	–	–	–	–	–	–	1.1	0.7 1.7	–	–	1.93	1.5 2.5	–	–
Jensen et al (2003)	–	–	3.2	2.2, 4.6	–	–	2.7	1.9 3.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Johnson et al (1992)	–	–	–	–	–	–	–	–	1.4	1.0 1.9	–	–	–	–	–	–	–	–	–	–	–	–
Kaiser et al (2001)	–	–	–	–	–	–	4.0	2.0 8.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Kiran et al (2005)	–	–	–	–	–	–	1.6	1.4 2.0	2.0	1.2 3.5	0.8	0.5 1.3	0.7	0.6 0.9	1.0	0.8 1.2	1.8	1.1 2.9	1.2	1.0 1.6	–	–
Konje et al (1993)	0.8	0.6 1.2	1.3	0.9 1.9	–	–	1.3	0.8 1.9	–	–	0.8	0.4 1.5	–	–	0.8	0.4 1.5	–	–	–	–	–	–
Kumari et al (2001)	–	–	–	–	–	–	2.4	1.2 4.9	3.1	1.1 9.0	1.9	0.8 4.7	–	–	–	–	–	–	–	–	–	–
Lombardi et al (2005)	–	–	–	–	–	–	1.9	1.5 2.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lumme et al (1995)	–	–	1.0	0.7 1.4	–	–	2.0	1.5 2.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mancuso et al (1991)	–	–	–	–	–	–	1.6	0.8 3.4	–	–	–	–	–	–	0.6	0.1 7.2	–	–	–	–	–	–
Ogunyemi et al (1998)	–	–	–	–	–	–	1.7	0.9 3.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Phithakwatchara and Titapant (2007)	–	–	–	–	–	–	–	–	1.5	1.2 1.9	–	–	–	–	–	–	–	–	–	–	–	–
Ranta et al (1995)	–	–	1.3	0.5 3.1	–	–	–	–	1.3	0.4 3.7	–	–	0.9	0.4 2.1	1.0	0.2 4.2	–	–	–	–	–	–
Rode et al (2005)	–	–	–	–	–	–	1.7	1.3 2.2	1.7	1.3 2.3	1.6	1.0 2.5	–	–	0.9	0.7 1.3	–	–	–	–	–	–
Rosenberg et al (2003)	–	–	–	–	–	–	a 2.1 c 2.7	a 2.0 2.2 c 2.2 3.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Rossner & Ohlin (1990)	–	–	–	–	–	–	–		–	–	–	–	0.8	0.5 1.4	–	–	–	–	–	–	–	–
Sheiner et al (2004)	–	–	2.3	2.1 2.6	–	–	3.2	2.9 3.5	–	–	–	–	–	–	–	–	–	–	–	–	3.1	2.5 3.7
Shepard et al (1998)	–	–	–	–	–	–	2.4	1.6 3.6	–	–	–	–	0.4	0.3 0.6	–	–	–	–	–	–	–	–
Steinfeld et al (2000)	–	–	–	–	–	–	2.1	1.5 3.1	–	–	–	–	–	–	0.6	0.3 1.0	–	–	–	–	–	–
Vahratian et al (2004)	–	–	1.2	0.9 1.8	2.5% (n=5) compared with 0% for ideal BMI		–	–	1.6	1.0 2.4	–	–	0.9	0.6 1.3	0.7	0.4 1.1	1.7	0.3 8.8	2.3	1.6 3.5	1.6	0.9 2.8
Weiss et al (2004)	–	–	–	–	–	–	a 1.7 b/c 3.0	a 1.4 2.2 b/c 2.2 4.0	–	–	–	–	–	–	a 1.0 b/c 1.7	a 0.8 1.3 b/c 1.2 2.2	–	–	–	–	–	–
Yekta et al (2006)	–	–	–	–	–	–	1.6	0.8 3.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Where data is split into obesity subgroups:

[a] Moderately Obese
[b] Severely Obese
[c] Morbidly Obese

Table 4: Results of Included Studies - Obese: Labour and Delivery 2

Paper	Premature Rupture of Membranes (PROM)		Placenta Abruption		Placenta Previa		Mal-presentation		Difficulty in Determining Fetal Lie		Labour Abnormalities		Occiput Posterior			
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Cerdergren (2004)	–	–	a 1.0 b 1.0 c 1.0	a 0.9 1.1 b 0.7 1.5 c 0.8 1.1	a 0.9 b 0.6 c 0.3	a 0.7 1.0 b 0.4 0.9 c 0.1 0.9	–	–	–	–	–	–	–	–		
Jensen et al (1999)	–	–	–	–	–	–	–	–	–	–	–	–	1.4	0.8 2.4		
Johnson et al (1992)	–	–	–	–	–	–	–	–	–	–	1.5	1.0 2.3	–	–		
Konje et al (1993)	1.3	0.6 3.0	–	–	–	–	–	–	12.8	4.4 41.8	–	–	–	–		
Kumari et al (2001)	–	–	c 1.6	c 0.1 25.0	c 0.8	c 0.1 8.8	–	–	–	–	–	–	–	–		
Lombardi et al (2005)	–	–	6.1	0.7 50.8	–	–	–	–	–	–	–	–	–	–		
Sheiner et al (2004)	1.2	1.0 1.5	0.4	0.2 1.2	0.8	0.4 1.9	1.4	1.2 1.6	–	–	–	–	–	–		
Vahratian et al (2004)	–	–	n=0 for obese		–	–	n= 0 for obese		–	–	–	–	–	–		
Weiss et al (2004)	a 1.3 b/c 1.3	a 0.9 2.0 b/c 0.8 2.2	a 1.0 b/c 1.0	a 0.6 1.9 b/c 0.5 2.2	a 1.3 b/c 0.7	a 0.7 2.5 b/c 0.3 2.0	–	–	–	–	–	–	–	–		

Where data is split into obesity subgroups:

[a] Moderately Obese
[b] Severely Obese
[c] Morbidly Obese

Table 5: Results of Included Studies - Obese: Labour and Delivery 3

Paper	Pain Score		Epidural		Pethidine		Nitrous Oxide		Duration of Labour (mean hours)		Primary Inertia		Secondary Inertia		Uterine Atony		Labour Dystocia			
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	Mean	SD	OR	95 % CI	OR	95 % CI	OR	95% CI	OR	95% CI	OR	95 % CI
Cerdergren (2004)	–	–	a 1.2 b 1.2 c 1.2	a 1.2 1.2 b 1.1 1.2 c 1.1 1.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–		
Ehrenberg et al (2004a)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.7	1.5 1.9		
Gaultier-Dereure et al (1995)	–	–	–	–	–	–	–	–	a 5.4 b/c 4.7	a 2.9 b/c 2.8	–	–	–	–	–	–	–	–		
Jensen et al (1999)	–		–	–	–	–	–	–	–	–	0.6	0.4 0.7	0.7 0	0.5 1.0	0.6	0.2 1.7	–	–		
Kiran et al (2005)	–	–	–	–	–	–	–	–	8.1	4.2	–	–	–	–	–	–	–	–		
Konje et al (1993)	–	–	0.2	0.1 0.3	–	–	–	–	5.4	not reported	–	–	–	–	–	–	–	–		
Ranta et al (1995)	Median 8	85% 7-10	0.7	0.4 1.3	12.4	3.0 50.9	6.4	3.2 13.0	Median 7	2-28 (range)	–	–	–	–	–	–	–	–		
Vahratian et al (2004)	–	–	0.8	0.6 1.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–		

Where data is split into obesity subgroups:

[a] Moderately Obese
[b] Severely Obese
[c] Morbidly Obese

Table 5: Results of Included Studies - Obese: Labour and Delivery 3

Paper	Pain Score		Epidural		Pethidine		Nitrous Oxide		Duration of Labour (mean hours)		Primary Inertia		Secondary Inertia		Uterine Atony		Labour Dystocia			
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	Mean	SD	OR	95 % CI	OR	95 % CI	OR	95% CI	OR	95% CI	OR	95 % CI
Cerdergren (2004)	–	–	a 1.2 b 1.2 c 1.2	a 1.2 1.2 b 1.1 1.2 c 1.1 1.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–		
Ehrenberg et al (2004a)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.7	1.5 1.9		
Gaultier-Dereure et al (1995)	–	–	–	–	–	–	–	–	a 5.4 b/c 4.7	a 2.9 b/c 2.8	–	–	–	–	–	–	–	–		
Jensen et al (1999)	–		–	–	–	–	–	–	–	–	0.6	0.4 0.7	0.7 0	0.5 1.0	0.6	0.2 1.7	–	–		
Kiran et al (2005)	–	–	–	–	–	–	–	–	8.1	4.2	–	–	–	–	–	–	–	–		
Konje et al (1993)	–	–	0.2	0.1 0.3	–	–	–	–	5.4	not reported	–	–	–	–	–	–	–	–		
Ranta et al (1995)	Median 8	85% 7-10	0.7	0.4 1.3	12.4	3.0 50.9	6.4	3.2 13.0	Median 7	2-28 (range)	–	–	–	–	–	–	–	–		
Vahratian et al (2004)	–	–	0.8	0.6 1.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–		

Where data is split into obesity subgroups:

[a] Moderately Obese
[b] Severely Obese
[c] Morbidly Obese

Table 6: Results of Included Studies - Obese: Birth Weight and Growth

Paper	Birth Weight (g)		Macrosomia		Large for Gestational Age		Low Birth Weight (<2500g)		Very Low Birth Weight (<1500g)		Small for Gestational Age		Intra Uterine Growth Restriction		Pre Term (<37 weeks)		Pre Term (<34 weeks)		Pre Term (<32 weeks)		Post Date (>41/42 weeks)	
	Mean	SD	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Abrams and Newman (1991)	–	–	–	–	–	–	–	–	–	–	Data for control group not provided	–	–	–	–	–	–	–	–	–	–	–
Baeten et al (2001)	–	–	2.1	1.9 2.3	–	–	1.1	0.9 1.2	–	–	0.8	0.8 0.9	–	–	1.3	1.2 1.5	–	–	1.6	1.2 2.1	–	–
Bianco et al (1998)	b/c 3352	b/c 598	–	–	b/c 1.8	b/c 1.4 2.3	–	–	–	–	b/c 0.8	b/c 0.5 1.2	–	–	b/c 1.3	b/c 1.0 1.6	–	–	–	–	–	–
Bo et al (2003)	3413	589	–	–	2.6	1.5 4.3	–	–	–	–			–	–	1.0	0.4 2.3	–	–	–	–	–	–
Callaway et al (2006)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	a/b 1.0 c 1.5	a/b 0.8 1.2 c 1.0 2.4	a/b 1.2 c 2.1	a/b 0.8 1.7 c 1.1 4.0	–	–	–	–
Cerdergren (2004)	–	–	a 2.2 b 3.0 c 3.6	a 2.1 2.2 b 2.9 3.2 c 3.2 3.9	a 2.2 b 3.1 c 3.8	a 2.1 2.3 b 3.0 3.3 c 3.5 4.2	–	–	–	–	a 1.0 b 1.0 c 1.4	a 0.9 1.0 b 0.9 1.2 c 1.1 1.7	–	–	a 1.2 b 1.5 c 1.9	a 1.1 1.3 b 1.4 1.6 c 1.6 2.1	–	–	a 1.5 b 2.0 c 2.3	a 1.3 1.6 b 1.7 2.3 c 1.7 3.1	a 1.4 b 1.5 c 1.8	a 1.3 1.4 b 1.4 1.6 c 1.6 2.0
Cnattingus et al (1998)	–	–	–	–	–	–	–	–	–	–	0.5	0.4 0.6	–	–	1.0	0.9 1.1	–	–	1.1	0.8 1.3	–	–
Crane et al (1997)	3519	633	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Di Cianni et al (1996)	–	–	4.8	1.1 20.5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Doherty et al (2006)	–	–	–	–	–	–	–	–	–	–	–	–	0.8	0.5 1.4	–	–	–	–	–	–	–	–
Ehrenberg et al (2004b)	3410	500	–	–	1.6	1.4 1.9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ekblad & Grenman (1992)	3712	614	–	–	5.1	2.5 10.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gaultier-Dereure et al (1995)	–	–	b/c 35.3	b/c 4.3 291.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hellerstedt et al (1997)	3420	760	–	–	1.9	1.3 2.7	–	–	–	–	0.7	0.4 1.0	–	–	1.5	1.0 2.2	–	–	–	–	–	–
Hendler et al (2005)	3289	660	3.4	2.7	4.3	–	–	–	–	–	–	–	–	–	0.6	0.4 0.8	0.6	0.3 1.2	0.5	0.2 1.3	–	–
Hulsey et al (2005)	–	–	–	–	–	–	0.8	0.6 1.1	1.4	1.1 1.8	–	–	–	–	–	–	–	–	–	–	–	–
Jensen et al (1999)	–	–	1.7	1.0 2.9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jensen et al (2003)	–	–	2.5	1.8 3.6	2.5	1.8 3.6	–	–	–	–	0.9	0.5 1.4	–	–	1.6	0.9 2.9	–	–	–	–	–	–
Johnson et al (1992)	–	–	3.2	2.2 4.7	–	–	0.0	0.0 0.3	–	–	–	–	–	–	–	–	–	–	–	–	1.5	1.0 2.2
Kiran et al (2005)	–	–	2.1	1.6 2.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.4	1.2 1.7
Konje et al (1993)	3692	NS	4.8	3.1 7.5	–	–	–	–	–	–	–	–	–	–	0.6	0.4 0.8	–	–	–	–	0.2	0.1 0.7
Kramer et al (1999)	–	–	–	–	–	–	–	–	–	–	–	–	Mild 0.6 Severe 0.7	Mild 0.5 0.7 Severe 0.5 1.0	–	–	–	–	–	–	–	–
Kugyelka et al (2004)	3378[1] 3466[2]	441[1] 459[2]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Kumari et al (2001)	–	–	c 3.8	c 2.1 7.0	–	–	c 0.3	c 0.1 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lombardi et al (2005)	3033	747	–	–	–	–	0.7	0.5 0.9	1.0	0.4 2.3	–	–	–	–	–	–	0.6	0.4 1.1	–	–	–	–
Lumme et al (1995)	–	–	2.3	1.7 3.0	2.3	1.7 3.0	0.7	0.3 1.3	–	–	0.5	0.3 0.8	–	–	1.1	0.7 1.7	–	–	–	–	1.1	0.6 1.9
Mancuso et al	–	–	1.8	1.4	–	–	1.6	0.5	–	–	–	–	–	–	2.6	1.0	–	–	–	–	4.0	0.4

(1991)				2.2				5.5								6.5						39.2
Naeye (1990)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.8	1.7 1.9	–	–	2.4	2.1 2.8	–	–
Nucci et al (2001)	–	–	–	–	1.5	1.1 2.2	–	–	–	–	0.5	0.3 0.8	–	–	–	–	–	–	–	–	–	–
Ogunyemi et al (1998)	3304	NS	–	–	–	–	0.8	0.2 2.5	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Olesen et al (2006)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	a 1.4 b/c 1.5	a 1.2 1.5 b/c 1.3 1.8
Phithakwatchara and Titapant (2007)	–	–	8.3	2.5 27.3	–	–	0.6	0.3 1.1	–	–	–	–	–	–	0.9	0.5 1.7	–	–	–	–	–	–
Ranta et al (1995)	3865	1610-5320 (range)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Rantakallio et al (1995)	–	–	–	–	–	–	a 0.6 b/c 1.1	a 0.2 1.3 b/c 0.3 3.6	–	–	a 0.5 b/c 0.8	a 0.3 0.9 b/c 0.3 2.0	–	–	a 1.2 b/c 1.3	a 0.7 2.0 b/c 0.5 3.3	–	–	–	–	–	–
Rode et al (2005)	–	–	–	–	–	–	2.8	1.4 5.6	–	–	–	–	–	–	1.4	0.9 1.9	–	–	–	–	1.4	1.1 1.9
Rosenberg et al (2003)	–	–	a/b 3.1 c 3.8	a/b 2.9 3.3 c 2.8 5.1	–	–	–	–	a/b 0.5 c 1.3	a/b 0.1 1.9 c 1.1 1.6	–	–	–	–	–	–	–	–	–	–	–	–
Rossner & Ohlin (1990)	3556	531	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sheiner et al (2004)	–	–	1.4	1.2 1.7	–	–	0.8	0.7 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Steinfeld te al (2000)	–	–	8.0	3.3 19.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Vahratian et al	3445	468	1.0	0.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

(2004)				1.7																		
Weiss et al (2004)	a 3430 b/c 3467	a 563 b/c 578	–	–	–	–	–	–	–	–	–	–	a 0.9 b/ c 0.8	a 0.5 1.6 b/c 0.4 1.8	a 1.1 b/c 1.5	a 0.9 1.5 b/c 1.1 2.1	–	–	–	–	–	–
Yetka et al (2006)	3470	588	–	–	–	–	0.4	0.1 1.7	–	–	–	–	–	–	0.4	0.1 1.7	–	–	–	–	–	–

Where data is split into obesity subgroups:

[a] Moderately Obese
[b] Severely Obese
[c] Morbidly Obese
[1] Black women only
[2] Hispanic women only

Table 6: Results of Included Studies - Obese: Birth Weight and Growth

Paper	Birth Weight (g)		Macrosomia		Large for Gestational Age		Low Birth Weight (<2500g)		Very Low Birth Weight (<1500g)		Small for Gestational Age		Intra Uterine Growth Restriction		Pre Term (<37 weeks)		Pre Term (<34 weeks)		Pre Term (<32 weeks)		Post Date (>41/42 weeks)	
	Mean	SD	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Abrams and Newman (1991)	–	–	–	–	–	–	–	–	–	–	Data for control group not provided	–	–	–	–	–	–	–	–	–	–	–
Baeten et al (2001)	–	–	2.1	1.9 2.3	–	–	1.1	0.9 1.2	–	–	0.8	0.8 0.9	–	–	1.3	1.2 1.5	–	–	1.6	1.2 2.1	–	–
Bianco et al (1998)	b/c 3352	b/c 598	–	–	b/c 1.8	b/c 1.4 2.3	–	–	–	–	b/c 0.8	b/c 0.5 1.2	–	–	b/c 1.3	b/c 1.0 1.6	–	–	–	–	–	–
Bo et al (2003)	3413	589	–	–	2.6	1.5 4.3	–	–	–	–			–	–	1.0	0.4 2.3	–	–	–	–	–	–
Callaway et al (2006)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	a/b 1.0 c 1.5	a/b 0.8 1.2 c 1.0 2.4	a/b 1.2 c 2.1	a/b 0.8 1.7 c 1.1 4.0	–	–	–	–
Cerdergren (2004)	–	–	a 2.2 b 3.0 c 3.6	a 2.1 2.2 b 2.9 3.2 c 3.2 3.9	a 2.2 b 3.1 c 3.8	a 2.1 2.3 b 3.0 3.3 c 3.5 4.2	–	–	–	–	a 1.0 b 1.0 c 1.4	a 0.9 1.0 b 0.9 1.2 c 1.1 1.7	–	–	a 1.2 b 1.5 c 1.9	a 1.1 1.3 b 1.4 1.6 c 1.6 2.1	–	–	a 1.5 b 2.0 c 2.3	a 1.3 1.6 b 1.7 2.3 c 1.7 3.1	a 1.4 b 1.5 c 1.8	a 1.3 1.4 b 1.4 1.6 c 1.6 2.0
Cnattingus et al (1998)	–	–	–	–	–	–	–	–	–	–	0.5	0.4 0.6	–	–	1.0	0.9 1.1	–	–	1.1	0.8 1.3	–	–
Crane et al (1997)	3519	633	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Di Cianni et al (1996)	–	–	4.8	1.1 20.5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Doherty et al (2006)	–	–	–	–	–	–	–	–	–	–	–	–	0.8	0.5 1.4	–	–	–	–	–	–	–	–
Ehrenberg et al (2004b)	3410	500	–	–	1.6	1.4 1.9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ekblad & Grenman (1992)	3712	614	–	–	5.1	2.5 10.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gaultier-Dereure et al (1995)	–	–	b/c 35.3	b/c 4.3 291.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hellerstedt et al (1997)	3420	760	–	–	1.9	1.3 2.7	–	–	–	–	0.7	0.4 1.0	–	–	1.5	1.0 2.2	–	–	–	–	–	–
Hendler et al (2005)	3289	660	3.4	2.7	4.3	–	–	–	–	–	–	–	–	–	0.6	0.4 0.8	0.6	0.3 1.2	0.5	0.2 1.3	–	–
Hulsey et al (2005)	–	–	–	–	–	–	0.8	0.6 1.1	1.4	1.1 1.8	–	–	–	–	–	–	–	–	–	–	–	–
Jensen et al (1999)	–	–	1.7	1.0 2.9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jensen et al (2003)	–	–	2.5	1.8 3.6	2.5	1.8 3.6	–	–	–	–	0.9	0.5 1.4	–	–	1.6	0.9 2.9	–	–	–	–	–	–
Johnson et al (1992)	–	–	3.2	2.2 4.7	–	–	0.0	0.0 0.3	–	–	–	–	–	–	–	–	–	–	–	–	1.5	1.0 2.2
Kiran et al (2005)	–	–	2.1	1.6 2.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.4	1.2 1.7
Konje et al (1993)	3692	NS	4.8	3.1 7.5	–	–	–	–	–	–	–	–	–	–	0.6	0.4 0.8	–	–	–	–	0.2	0.1 0.7
Kramer et al (1999)	–	–	–	–	–	–	–	–	–	–	–	–	Mild 0.6 Severe 0.7	Mild 0.5 0.7 Severe 0.5 1.0	–	–	–	–	–	–	–	–
Kugyelka et al (2004)	3378[1] 3466[2]	441[1] 459[2]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Kumari et al (2001)	–	–	c 3.8	c 2.1 7.0	–	–	c 0.3	c 0.1 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lombardi et al (2005)	3033	747	–	–	–	–	0.7	0.5 0.9	1.0	0.4 2.3	–	–	–	–	–	–	0.6	0.4 1.1	–	–	–	–
Lumme et al (1995)	–	–	2.3	1.7 3.0	2.3	1.7 3.0	0.7	0.3 1.3	–	–	0.5	0.3 0.8	–	–	1.1	0.7 1.7	–	–	–	–	1.1	0.6 1.9
Mancuso et al	–	–	1.8	1.4	–	–	1.6	0.5	–	–	–	–	–	–	2.6	1.0	–	–	–	–	4.0	0.4

(1991)				2.2				5.5								6.5						39.2
Naeye (1990)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.8	1.7 1.9	–	–	2.4	2.1 2.8	–	–
Nucci et al (2001)	–	–	–	–	1.5	1.1 2.2	–	–	–	–	0.5	0.3 0.8	–	–	–	–	–	–	–	–	–	–
Ogunyemi et al (1998)	3304	NS	–	–	–	–	0.8	0.2 2.5	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Olesen et al (2006)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	a 1.4 b/c 1.5	a 1.2 1.5 b/c 1.3 1.8
Phithakwatchara and Titapant (2007)	–	–	8.3	2.5 27.3	–	–	0.6	0.3 1.1	–	–	–	–	–	–	0.9	0.5 1.7	–	–	–	–	–	–
Ranta et al (1995)	3865	1610-5320 (range)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Rantakallio et al (1995)	–	–	–	–	–	–	a 0.6 b/c 1.1	a 0.2 1.3 b/c 0.3 3.6	–	–	a 0.5 b/c 0.8	a 0.3 0.9 b/c 0.3 2.0	–	–	a 1.2 b/c 1.3	a 0.7 2.0 b/c 0.5 3.3	–	–	–	–	–	–
Rode et al (2005)	–	–	–	–	–	–	2.8	1.4 5.6	–	–	–	–	–	–	1.4	0.9 1.9	–	–	–	–	1.4	1.1 1.9
Rosenberg et al (2003)	–	–	a/b 3.1 c 3.8	a/b 2.9 3.3 c 2.8 5.1	–	–	–	–	a/b 0.5 c 1.3	a/b 0.1 1.9 c 1.1 1.6	–	–	–	–	–	–	–	–	–	–	–	–
Rossner & Ohlin (1990)	3556	531	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sheiner et al (2004)	–	–	1.4	1.2 1.7	–	–	0.8	0.7 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Steinfeld te al (2000)	–	–	8.0	3.3 19.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Vahratian et al	3445	468	1.0	0.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

(2004)				1.7																		
Weiss et al (2004)	a 3430 b/c 3467	a 563 b/c 578	–	–	–	–	–	–	–	–	–	–	a 0.9 b/ c 0.8	a 0.5 1.6 b/c 0.4 1.8	a 1.1 b/c 1.5	a 0.9 1.5 b/c 1.1 2.1	–	–	–	–	–	–
Yetka et al (2006)	3470	588	–	–	–	–	0.4	0.1 1.7	–	–	–	–	–	–	0.4	0.1 1.7	–	–	–	–	–	–

Where data is split into obesity subgroups:

[a] Moderately Obese
[b] Severely Obese
[c] Morbidly Obese
[1] Black women only
[2] Hispanic women only

Table 7: Results Table for Maternal Complications for Obese BMI Group

Paper	Haemorrhage		Transfusion		Infection		Retained Placenta		Evacuation Uterus		Thromboembolic Events		Overall Puerperal Complications		3rd/4th Degree Tears (incl. anal sphincter tear)		Vaginal Repair/ Perineal Trauma	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Bianco et al (1998)	b/c 1.4	b/c 0.6 3.4	–	–	b/c 5.0	b/c 1.6 15.0	–	–	–	–	–	–	–	–	–	–	–	–
Cerdergren (2004)	a 1.2 b 1.4 c 1.7	a 1.2 1.2 b 1.3 1.5 c 1.5 2.0	–	–	–	–	–	–	–	–	–	–	–	–	a 1.0 b 1.0 c 1.0	a 1.0 1.1 b 0.9 1.2 c 0.8 1.4	–	–
Doherty et al (2006)	1.7	1.2 2.4	–	–	2.0	1.1 3.8	0.6	0.1 2.5	–	–	–	–	–	–	–	–	1.6	1.1 2.3
Ekblad & Grenman (1992)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	n= 0 for obese	–
Giuliani et al (2002)	0.4	0.1 1.3	–	–	1.7	1.3 2.3	–	–	–	–	n= 0 for obese		1.2	0.9 1.6	–	–	–	–
Jensen et al (1999)	2.5	0.8 7.6	–	–	–	–	0.6	0.2 1.9	–	–	–	–	–	–	–	–	1.0	0.5 1.8
Kiran et al (2005)	1.3	0.8 2.4	1.3	0.9 2.0	10.4	5.2 20.7	–	–	0.6	0.2 2.1	–	–	–	–	1.1	0.4 2.7	–	–
Konje et al (1993)	data		–	–	8.4	2.1 73.4	0.7	0.2 3.0	–	–	–	–	–	–	–	–	–	–
Lumme et al (1995)	2.0	1.5 2.7	–	–	6.5	4.6 9.1	–	–	–	–	–	–	–	–	–	–	–	–
Ranta et al (1995)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.0	0.5 1.9
Sheiner et al (2004)	1.0	0.5 2.1	1.4	0.9 1.9	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Where data is split into obesity subgroups:

[a] Moderately Obese
[b] Severely Obese
[c] Morbidly Obese

Table 8: Results Table for Neonate Outcomes for Obese BMI Group 1

Paper	Low Apgar Score 1 minute		Low Apgar Score 5 minute		Fetal Compromise		Presence of Meconium		Shoulder Dystocia		Jaundice		Phototherapy		Cord pH		Tube Feeding	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Bergholt et al (2007)	–	–	–	–	a 2.2 b/c 4.4	a 1.1 4.4 b/c 2.0 10.1	–	–	–	–	–	–	–	–	–	–	–	–
Bianco et al (1998)	b/c 1.8	b/c 0.8 3.8	b/c 1.8	b/c 0.6 4.9	b/c 1.3	b/c 1.1 1.7	b/c 1.3	b/c 1.1 1.7	b/c 1.5	b/c 0.8 2.8	–	–	–	–	–	–	–	–
Callaway et al (2006)	–	–	–	–	–	–	–	–	–	–	a/b 1.0 c 1.4	a/b 0.9 1.1 c 1.1 1.9	a/b 1.0 c 1.7	a/b 0.8 1.4 c 1.0 2.9	–	–	–	–
Cerdergren (2004)	–	–	a 1.6 b 1.8 c 2.9	a 1.5 1.7 b 1.6 2.1 c 2.4 3.6	a 1.6 b 2.1 c 2.5	a 1.5 1.7 b 1.9 2.4 c 2.1 3.0	a 1.6 b 2.9 c 2.9	a 1.3 2.1 b 2.1 3.9 c 1.6 5.1	a 1.0 b 1.0 c 1.0	a 1.0 1.2 b 0.9 1.2 c 0.8 1.4	–	–	–	–	–	–	–	–
Dempsey et al (2005)	–	–	–	–	3.7	1.4 10.2	–	–	–	–	–	–	–	–	–	–	–	–
Doherty et al (2006)	–	–	–	–	4.6	2.2 9.4	–	–	–	–	–	–	–	–	–	–	–	–
Ekblad and Grenman (1992)	8.4 (mean)	1.5 (SD)	8.8 (mean)	1.1 (SD)	–	–	–	–	n= 0 for obese		–	–	–	–	–	–	–	–
Jensen et al (1999)	–	–	2.0	0.4 9.2	–	–	–	–	1.9	0.7 4.9	–	–	–	–	–	–	–	–
Jensen et al (2003)	–	–	–	–	–	–	–	–	0.9	0.4 2.2	1.0	0.6 1.7	–	–	–	–	–	–
Johnson et al (1992)	–	–	–	–	1.3	1.1 1.7	1.8	1.3 2.3	–	–	–	–	–	–	–	–	–	–
Kiran et al (2005)	–	–	1.3	0.6 2.8	–	–	–	–	2.9	1.4 5.8	–	–	–	–	1.5	0.7 3.3	1.5	1.1 2.1
Kumari et al	c	c	–	–	–	–	–	–	c	c	–	–	–	–	–	–	–	–

(2001)	1.5	0.3 8.2							3.2	0.6, 17.7								
Lumme et al (1995)	1.0	0.2 2.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mancuso et al (1991)	3.8	1.7 8.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Phithakwatchara and Titapant (2007)	–	–	–	–	–	–	–	–	1.7	1.3 2.2	0.9	0.5 1.8	–	–	–	–	–	–
Sheiner et al (2004)	1.0	0.8 1.3	1	0.5 1.8	–	–	1.4	1.2 1.6	1.6	0.7 4.0	–	–	–	–	–	–	–	–
Vahratian et al (2004)	–	–	–	–	1.5	0.8 2.9	–	–	–	–	–	–	–	–	–	–	–	–

Where data is split into obesity subgroups:

[a] Moderately Obese
[b] Severely Obese
[c] Morbidly Obese

Table 9: Results Table for Neonate Outcomes for Obese BMI Group 2

Paper	Hypoglycaemia		Hyperbilirubinaemia		Mechanically ventilated		Birth Trauma		Respiratory distress		Resuscitation		Incubator required		Asphyxia		Fetal Heart Rate Abnormalities	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Callaway et al (2006)	–	–	–	–	a/b 1.8 c 3.0	a/b 0.9 3.5 c 0.9 10.0	–	–	a/b 1.5 c 1.4	a/b 1.0 2.2 c 0.6 3.4	–	–	–	–	–	–	–	–
Di Cianni et al (1996)	–	–	1.8	0.5 6.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Doherty et al (2006)	–	–	–	–	–	–	–	–	–	–	1.8	1.3 2.4	–	–	–	–	–	–
Jensen et al (1999)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.0	0.5 1.8	–	–
Jensen et al (2003)	0.9	0.5 1.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Johnson et al (1992)	–	–	–	–	–	–	–	–	–	–	Data not provided		–	–	–	–	1.3	1.0 1.7
Kiran et al (2005)	–	–	–	–	–	–	1.5	1.1 2.1	–	–	–	–	1.6	1.0 2.6	2.8	0.6 13.4	–	–
Naeye (1990)	–	–	–	–	–	–	1.4	0.2 12.4	1.7	1.4 2.1	–	–	–	–	–	–	–	–

Where data is split into obesity subgroups:

[a] Moderately Obese
[b] Severely Obese
[c] Morbidly Obese

Table 10: Results Table for Hospital Admission for Obese BMI Group

Paper	Neonatal Intensive Care		Length of Stay		Readmission to Hospital		Outpatient Hospitalisation During Pregnancy		Inpatient Hospitalisation During Pregnancy		Hospital Admission During Pregnancy		Daytime Hospitalisation		Night Time Hospitalisation		Cost of Prenatal Care	
	OR	95% CI	Mean	SD	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	Mean	SD
Bianco et al (1998)	b/c 1.2	b/c 1.0 1.3	b/c 3.2	b/c 2.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Callaway et al (2006)	a/b 1.3 c 2.8	a/b 1.0 1.6 c 1.8 4.3	a/b 3.1 c 3.9	a/b 2.8 c 3.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ekblad and Grenman (1992)	1.5	0.2 8.9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gaultier-Dereure et al (1995)	–	–	a 3.7 b/c 8.6	a 7.1 b/c 15.2	–	–	a 10.4 b/c 20.0	a 3.1 35.6 b/c 5.5 72.6	a 5.6 b/c 18.5	a 1.8 17.9 b/c 5.4 63.0	–	–	–	–	–	–	–	–
Gaultier-Dereure et al (2000)	–	–	–	–	–	–	–	–	–	–	–	–	d 3.9	Not specified	d 6.2	Not specified	d 4.5	d 6.0
Giuliani et al (2002)	–	–	–	–	0.4	0.1 2.8	–	–	–	–	–	–	–	–	–	–	–	–
Kiran et al (2005)	1.5	1.1 2.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Kugyelka et al (2004)	–	–	2.5[1] 2.5[2]	1.1[1] 1.1[2]	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Kumari et al (2001)	c 7.3	c 2.9 18.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lumme et al (1995)	1.4	1.0 1.9	–	–	–	–	–	–	–	–	2.7	2.2 3.3	–	–	–	–	–	–
Ogunyemi et al (1998)	3.0	1.0 8.5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ranta et al (1995)	n= 0 for obese		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Where data is split into obesity subgroups:

[a] Moderately Obese
[b] Severely Obese
[c] Morbidly Obese
[d] Overweight and Obese
[1] Black women only
[2] Hispanic women only

Table 11: Meta Analysis Results: Primary Outcomes

	Underweight vs. Ideal BMI	Overweight vs. Ideal BMI	Obese vs. Ideal BMI	Morbidly Obese vs. Ideal BMI
	OR (95% CI)			
LABOUR & DELIVERY				
Total Caesarean delivery	0.807 (0.720, 0.903)* n=9	1.483 (1.390, 1.581)* n=14	2.005 (1.872, 2.148)*# n=16	1.432 (1.346, 1.524)~ n=6
Elective Caesarean delivery	-	-	1.240 (0.899,1.710) n=3	
Emergency Caesarean delivery	-	-	1.626(1.396,1.893)* n=6	
Instrumental delivery	-	0.773 (0.674, 0.888)* n=3	1.169(1.130,1.209)*# n=4	
HOSPITAL ADMISSION				
Length of hospital stay (mean days) ^	-	2.563 (2.460, 2.666) n=6	2.706 (2.623, 2.788) n=4	3.279 (3.131, 3.428) n=3
Neonatal Intensive Care Unit Use	-	1.121 (0.979, 1.283) n=3	1.377 (1.157, 1.639) n=4	1.331 (1.175, 1.507) n=3
MOTHER				
Haemorrhage	0.671 (0.547, 0.822)* n=4	1.420 (1.095, 1.842)* n=3	1.202 (1.163, 1.243)# n=4	1.430 (1.328, 1.540)# n=3
Infection	-	-	3.335(2.738,4.062) n=6	

- Data not available for meta analysis
* No significant heterogeneity
\# Results following sensitivity analysis
~Sensitivity analysis with non obese comparison group rather than ideal BMI shows no heterogeneity and increases odds to 2.36 (2.03,2.73)
^ Length of stay compared with women in the Ideal BMI category where OR 2.421(2.407, 2.434)

Table 12: Meta Analysis Results – Secondary Outcomes

	Underweight vs. Ideal BMI	Overweight vs. Ideal BMI	Obese vs. Ideal BMI	Morbidly Obese vs. Ideal BMI
	OR (95% CI)			
BIRTH WEIGHT & GROWTH				
Birth weight (mean)[$]	3225 (3206, 3243)# n=4	3334 (3317, 3351)* n=3	3429(3418,3439) n=15	
Low Birth Weight	1.781 (1.677, 1.891)* n=11	0.933 (0.890, 0.978) n=14	0.841 (0.782, 0.905) n=19	1.113 (0.924, 1.340) n=5
High Birth Weight	0.522 (0.458, 0.596) n=4	1.308 (1.215, 1.407)*# n=8	2.357(2.293,2.422)# n=15	
>41/42 weeks	-	1.282 (1.198, 1.372)* n=3	1.370 (1.332, 1.409)* n=4	1.556 (1.479, 1.636) n=3
<37 weeks	1.049 (0.871, 1.265)* n=3	1.166 (1.051, 1.293)* n=6	1.226 (1.149, 1.308)* n=9	1.495 (1.409, 1.587) n=6
<34 weeks	-	-	0.885 (0.670, 1.169)* n=3	-
<32 weeks	-	-	1.586(1.467,1.715) n=4	
LABOUR & DELIVERY				
Labour onset induced	0.728 (0.639, 0.829)# n=4	1.302 (1.163, 1.458)*# n=3	1.880(1.844,1.917)# n=10	
Oxytocin	-	-	1.593 (1.356, 1.872) n=3	
Epidural	-	-	1.228 (1.191, 1.266) n=5	
Vaginal Delivery	-	0.777 (0.712, 0.847) n=3	0.654(0.592,0.722)*# n=4	
Failure to progress	-	-	2.306(1.871,2.842)* n=4	
Placenta Abruption	-	-	0.984(0.899,1.078)* n=8	
Placenta Previa	-	-	0.826(0.714,0.955)* n=7	

NEONATE				
Low apgar score (1 minute)	-	-	1.494(0.808,2.763)*# n=3	
Low apgar score (5 minutes)	-	-	1.570 (1.465, 1.682)* n=4	2.095 (1.866, 2.353) n=3
Fetal compromise	-	2.062 (1.439, 2.955)* n=4	1.623 (1.545, 1.705) n=5	2.082 (1.924, 2.254) n=4
Meconium	-	-	1.570(1.422,1.732) n=5	
Shoulder dystocia	-	-	1.042(0.966,1.125) n=9	
Jaundice	-	-	1.041 (0.933,1.162)* n=4	
MOTHER				
Tears / lacerations	-	-	1.021(0.969,1.076)* n=7	

- Data not available for meta analysis
* No significant heterogeneity
# Results following sensitivity analysis
$ Birth weight (g) compared with women in the ideal BMI category where mean birth weight 3281 (3273, 3288)